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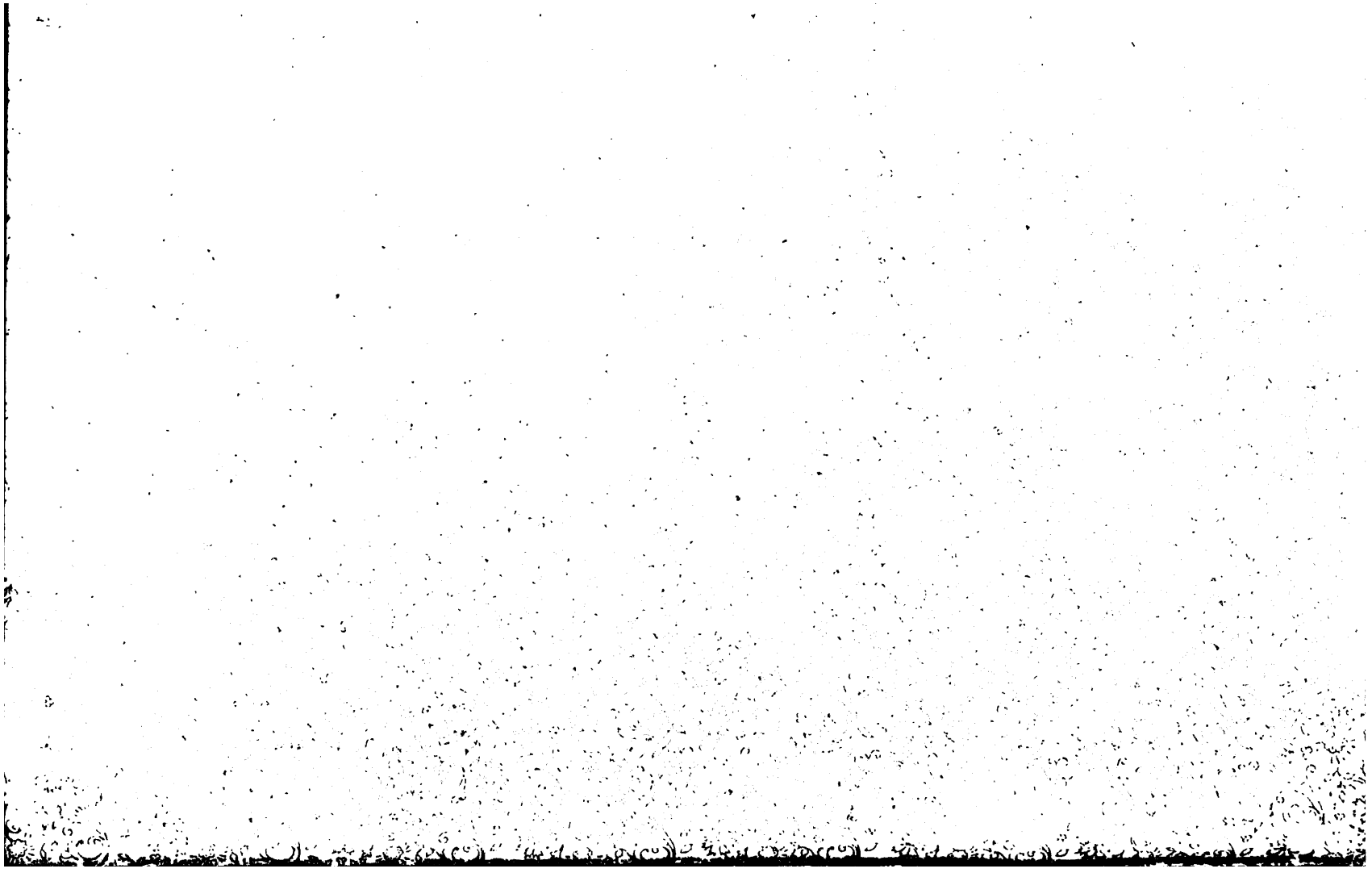

TRANSACTIONS

OF THE

AMERICAN DENTAL ASSOCIATION

AT THE

THIRTY-SEVENTH ANNUAL SESSION,

HELD AT

OLD POINT COMFORT, VA.

Commencing on the 3d of August, 1897.

ALSO

APPENDIX,

Containing Minutes of the Convention and First Meeting of the National Dental Association.

PUBLICATION COMMITTEE:

GEO. H. CUSHING. E. T. DARBY. A. W. HARLAN.

PHILADELPHIA:
THE S. S. WHITE DENTAL MANUFACTURING COMPANY.
1898.

DISCLAIMER.

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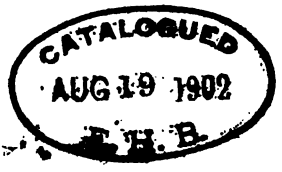

PRESS OF PATTERSON & WHITE,
PHILADELPHIA.

LIST OF OFFICERS FROM DATE OF ORGANIZATION.

PRELIMINARY CONVENTION, NIAGARA FALLS, AUGUST, 1859.

President,	W. W. ALLPORT . .	. Chicago, Ill.
Secretary,	J. TAFT . . .	. Cincinnati, Ohio.

ORGANIZATION AND FIRST SESSION OF ASSOCIATION, WASHINGTON, D. C., JULY, 1860.

[Annual meetings to be hereafter, last Tuesday in July.]

President,	W. H. ATKINSON .	Cleveland, Ohio.
1st Vice-President,	J. B. GIBBS . . .	. Washington, D. C.
2d Vice-President,	W. CAHOON . . .	. Detroit, Michigan.
Recording Secretary,	J. TAFT . . .	. Cincinnati, Ohio.
Corresponding Secretary,	W. MUIR ROGERS .	. Shelbyville, Ky.
Treasurer,	S. DILLINGHAM . .	. Philadelphia, Pa.

[NO MEETING IN 1861.]

CLEVELAND, JULY, 1862.

President,	GEO. WATT . . .	. Xenia, Ohio.
1st Vice-President,	W. H. ALLEN . .	. New York City.
2d Vice-President,	W. D. STONE . .	. Lexington, Ky.
Recording Secretary,	J. TAFT . . .	. Cincinnati, Ohio.
Corresponding Secretary,	J. F. JOHNSTON .	. Indianapolis, Ind.
Treasurer,	W. A. PEASE . .	. Dayton, Ohio.

PHILADELPHIA, JULY, 1863.

President,	W. H. ALLEN . .	. New York City.
1st Vice-President,	J. H. MCQUILLEN .	. Philadelphia, Pa.
2d Vice-President,	WM. B. HURD . .	. Brooklyn, N. Y.
Recording Secretary,	J. TAFT . . .	. Cincinnati, Ohio.
Corresponding Secretary,	C. R. BUTLER . .	. Cleveland, Ohio.
Treasurer,	A. C. HAWES . .	. New York City.

NIAGARA FALLS, JULY, 1864.

President,	J. H. MCQUILLEN .	. Philadelphia, Pa.
1st Vice-President,	C. P. FITCH . .	. New York City.
2d Vice-President,	H. BENEDICT . .	. Detroit, Mich.
Recording Secretary,	J. TAFT . . .	. Cincinnati, Ohio.
Corresponding Secretary,	GEO. W. ELLIS . .	. Philadelphia, Pa.
Treasurer,	I. J. WETHERBEE .	. Boston, Mass.

CHICAGO, JULY, 1865.

President,	C. W. SPALDING . .	. St. Louis, Mo.
1st Vice-President,	GEO. H. CUSHING .	. Chicago, Ill.
2d Vice-President,	JAS. MCMANUS . .	. Hartford, Conn.
Recording Secretary,	J. TAFT . . .	. Cincinnati, Ohio.
Corresponding Secretary,	L. D. SHEPARD . .	. Boston, Mass.
Treasurer,	I. J. WETHERBEE .	. Boston, Mass.

BOSTON, JULY, 1866.

President,	C. P. FITCH . . .	New York City.
1st Vice-President,	W. H. MORGAN . . .	Nashville, Tenn.
2d Vice-President,	L. D. SHEPARD . . .	Boston, Mass.
Recording Secretary,	J. TAFT	Cincinnati, Ohio.
Corresponding Secretary,	A. HILL	Norwalk, Conn.
Treasurer,	W. W. SHEFFIELD . .	New London, Conn.

CINCINNATI, JULY, 1867.

President,	A. LAWRENCE . . .	Lowell, Mass.
1st Vice-President,	P. G. C. HUNT . . .	Indianapolis, Ind.
2d Vice-President,	A. S. TALBERT . . .	Lexington, Ky.
Recording Secretary,	J. TAFT	Cincinnati, Ohio.
Corresponding Secretary,	C. R. BUTLER . . .	Cleveland, Ohio.
Treasurer,	W. H. GODDARD . . .	Louisville, Ky.

NIAGARA FALLS, JULY, 1868.

President,	JONATHAN TAFT . . .	Cincinnati, Ohio.
1st Vice-President,	HOMER JUDD . . .	St. Louis, Mo.
2d Vice-President,	A. A. BLOUNT . . .	Springfield, Ohio.
Recording Secretary,	EDGAR PARK . . .	St. Louis, Mo.
Corresponding Secretary,	JAS. MCMANUS . . .	Hartford, Conn.
Treasurer,	W. H. GODDARD . . .	Louisville, Ky.

SARATOGA SPRINGS, AUGUST, 1869.*

President,	HOMER JUDD . . .	St. Louis, Mo.
1st Vice-President,	S. J. COBB . . .	Nashville, Tenn.
2d Vice-President,	C. E. FRANCIS . . .	New York City
Recording Secretary,	M. S. DEAN . . .	Chicago, Ill.
Corresponding Secretary,	I. A. SALMON . . .	Boston, Mass.
Treasurer,	W. H. GODDARD . . .	Louisville, Ky.

NASHVILLE, AUGUST, 1870.

President,	W. H. MORGAN . . .	Nashville, Tenn.
1st Vice-President,	S. W. DENNIS . . .	San Francisco, Cal.
2d Vice-President,	J. R. WALKER . . .	New Orleans, La.
Recording Secretary,	M. S. DEAN . . .	Chicago, Ill.
Corresponding Secretary,	I. A. SALMON . . .	Boston, Mass.
Treasurer,	W. H. GODDARD . . .	Louisville, Ky.

WHITE SULPHUR SPRINGS, VA., AUGUST, 1871.

President,	GEO. H. CUSHING . .	Chicago, Ill.
1st Vice-President,	C. E. FRANCIS . . .	New York City.
2d Vice-President,	J. R. WALKER . . .	New Orleans, La.
Recording Secretary,	M. S. DEAN . . .	Chicago, Ill.
Corresponding Secretary,	I. A. SALMON . . .	Boston, Mass.
Treasurer,	W. H. GODDARD . . .	Louisville, Ky.

*Owing to a change in the Constitution, officers elected at this and the sessions following served at the next annual meeting subsequent to their election; and the sessions of and after 1869 commenced on the first Tuesday in August.

NIAGARA FALLS, AUGUST, 1872.

President,	P. G. C. HUNT	Indianapolis, Ind.
1st Vice-President,	L. D. SHEPARD	Boston, Mass.
2d Vice-President,	G. A. MILLS	Brooklyn, N. Y.
Recording Secretary,	M. S. DEAN	Chicago, Ill.
Corresponding Secretary,	J. TAFT	Cincinnati, Ohio.
Treasurer,	W. H. GODDARD	Louisville, Ky.

PUT-IN-BAY, AUGUST, 1873.

President,	T. L. BUCKINGHAM	Philadelphia, Pa.
1st Vice-President,	ISAIAH FORBES	St. Louis, Mo.
2d Vice-President,	A. F. MCLAIN	New Orleans, La.
Recording Secretary,	M. S. DEAN	Chicago, Ill.
Corresponding Secretary,	J. TAFT	Cincinnati, Ohio.
Treasurer,	W. H. GODDARD	Louisville, Ky.

DETROIT, AUGUST, 1874.

President,	M. S. DEAN	Chicago, Ill.
1st Vice-President,	GEO. W. KEELY	Oxford, Ohio.
2d Vice-President,	J. S. KNAPP	New Orleans, La.
Recording Secretary,	C. STODDARD SMITH	Springfield, Ill.
Corresponding Secretary,	GEO. L. FIELD	Detroit, Mich.
Treasurer,	W. H. GODDARD	Louisville, Ky.

NIAGARA FALLS, AUGUST, 1875.

President,	A. L. NORTHROP	New York City.
1st Vice-President,	H. J. MCKELLOPS	St. Louis, Mo.
2d Vice-President,	H. A. SMITH	Cincinnati, Ohio.
Recording Secretary,	C. STODDARD SMITH	Springfield, Ill.
Corresponding Secretary,	J. H. MCQUILLEN	Philadelphia, Pa.
Treasurer,	W. H. GODDARD	Louisville, Ky.

PHILADELPHIA, AUGUST, 1876.

President,	GEO. W. KEELY	Oxford, Ohio.
1st Vice-President,	C. N. PEIRCE	Philadelphia, Pa.
2d Vice-President,	CORYDON PALMER	New York City.
Recording Secretary,	C. STODDARD SMITH	Springfield, Ill.
Corresponding Secretary,	J. H. MCQUILLEN	Philadelphia, Pa.
Treasurer,	W. H. GODDARD	Louisville, Ky.

CHICAGO, AUGUST, 1877.

President,	F. H. REHWINKEL	Chillicothe, Ohio.
1st Vice-President,	L. D. SHEPARD	Boston, Mass.
2d Vice-President,	GEO. T. BARKER	Philadelphia, Pa.
Recording Secretary,	M. S. DEAN	Chicago, Ill.
Corresponding Secretary,	M. H. WEBB	Lancaster, Pa.
Treasurer,	W. H. GODDARD	Louisville, Ky.

NIAGARA FALLS, AUGUST, 1878.

President,	H. J. McKELLOPS	St. Louis, Mo.
1st Vice-President,	L. D. SHEPARD	Boston, Mass.
2d Vice-President,	L. D. CARPENTER	Atlanta, Ga.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	A. O. RAWLS	Lexington, Ky.
Treasurer,	W. H. GODDARD	Louisville, Ky.

NIAGARA FALLS, AUGUST, 1879.

President,	L. D. SHEPARD	Boston, Mass.
1st Vice-President,	C. N. PEIRCE	Philadelphia, Pa.
2d Vice-President,	GEO. L. FIELD	Detroit, Mich.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	M. H. WEBB	Lancaster, Pa.
Treasurer,	W. H. GODDARD	Louisville, Ky.

BOSTON, AUGUST, 1880.

President,	C. N. PEIRCE	Philadelphia, Pa.
1st Vice-President.	W. C. BARRETT	Buffalo, N. Y.
2d Vice-President,	GEO. J. FRIEDRICHS	New Orleans, La.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	A. M. DUDLEY	Salem, Mass.
Treasurer,	W. H. GODDARD	Louisville, Ky.

NEW YORK, JULY, 1881.

President,	H. A. SMITH	Cincinnati, Ohio.
1st Vice-President,	W. C. BARRETT	Buffalo, N. Y.
2d Vice-President,	GEO. J. FRIEDRICHS	New Orleans, La.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	A. M. DUDLEY	Salem, Mass.
Treasurer,	W. H. GODDARD	Louisville, Ky.

CINCINNATI, AUGUST, 1882.

President,	W. H. GODDARD	Louisville, Ky.
1st Vice-President,	GEO. J. FRIEDRICHS	New Orleans, La.
2d Vice-President,	E. T. DARBY	Philadelphia, Pa.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	A. W. HARLAN	Chicago, Ill.
Treasurer,	GEO. W. KEELY	Oxford, Ohio.

NIAGARA FALLS, AUGUST, 1883.

President,	E. T. DARBY	Philadelphia, Pa.
1st Vice-President,	C. S. STOCKTON	Newark, N. J.
2d Vice-President,	T. T. MOORE	Columbia, S. C.
Recording Secretary,	GEO. H. CUSHING	Chicago, Ill.
Corresponding Secretary,	A. W. HARLAN	Chicago, Ill.
Treasurer,	GEO. W. KEELY	Oxford, Ohio.

SARATOGA SPRINGS, AUGUST, 1884.

President,	J. N. CROUSE	. Chicago, Ill.
1st Vice-President,	M. W. FOSTER	. Baltimore, Md.
2d Vice-President,	C. F. RICH	. Saratoga, N. Y.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	A. W. HARLAN	. Chicago, Ill.
Treasurer,	GEO. W. KEELY	. Oxford, Ohio.

MINNEAPOLIS, AUGUST, 1885.

President,	W. C. BARRETT	. Buffalo, N. Y.
1st Vice-President,	L. C. INGERSOLL	. Keokuk, Iowa.
2d Vice-President,	A. T. SMITH	. Minneapolis, Minn.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	A. W. HARLAN	. Chicago, Ill.
Treasurer,	GEO. W. KEELY	. Oxford, Ohio.

NIAGARA FALLS, 1886.

President,	W. W. ALLPORT	. Chicago, Ill.
1st Vice-President,	GEO. W. MCELHANEY	. Columbus, Ga.
2d Vice-President,	S. W. DENNIS	. San Francisco, Cal.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	A. W. HARLAN	. Chicago, Ill.
Treasurer,	GEO. W. KEELY	. Oxford, Ohio.

NIAGARA FALLS, 1887.

President,	FRANK ABBOTT	. New York City.
1st Vice-President,	CHARLES R. BUTLER	. Cleveland, Ohio.
2d Vice-President,	T. SOLLERS WATERS	. Baltimore, Md.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY	. Orange, N. J.
Treasurer,	GEO. W. KEELY	. Oxford, Ohio.

LOUISVILLE, KY., 1888.

President,	C. R. BUTLER	. Cleveland, Ohio.
1st Vice-President,	A. W. HARLAN	. Chicago, Ill.
2d Vice-President,	SAMUEL A. WHITE	. Savannah, Ga.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY	. Orange, N. J.
Treasurer,	A. H. FULLER	. St. Louis, Mo.

SARATOGA SPRINGS, 1889.

President,	M. W. FOSTER	. Baltimore, Md.
1st Vice-President,	A. W. HARLAN	. Chicago, Ill.
2d Vice-President,	J. D. PATTERSON	. Kansas City, Mo.
Recording Secretary,	GEO. H. CUSHING	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY	. Orange, N. J.
Treasurer,	A. H. FULLER	. St. Louis, Mo.

EXCELSIOR SPRINGS, MO., 1890.

President,	A. W. HARLAN . .	. Chicago, Ill.
1st Vice-President,	J. D. PATTERSON .	. Kansas City, Mo.
2d Vice-President,	H. B. NOBLE .	. Washington, D. C.
Recording Secretary,	GEO. H. CUSHING . .	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY . .	. Orange, N. J.
Treasurer,	A. H. FULLER . .	. St. Louis, Mo.

SARATOGA SPRINGS, 1891.

President,	W. W. WALKER . .	. New York City.
1st Vice-President,	J. D. PATTERSON .	. Kansas City, Mo.
2d Vice-President,	S. C. G. WATKINS .	. Mont Clair, N. J.
Recording Secretary,	GEO. H. CUSHING .	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY . .	. Orange, N. J.
Treasurer,	A. H. FULLER . .	. St. Louis, Mo.

NIAGARA FALLS, 1892.*

President,	J. D. PATTERSON .	. Kansas City, Mo.
1st Vice-President,	J. Y. CRAWFORD .	. Nashville, Tenn.
2d Vice-President,	S. C. G. WATKINS .	. Mont Clair, N. J.
Recording Secretary,	GEO. H. CUSHING .	. Chicago, Ill.
Corresponding Secretary,	FRED. A. LEVY . .	. Orange, N. J.
Treasurer,	A. H. FULLER . .	. St. Louis, Mo.

OLD POINT COMFORT, AUGUST, 1894.

President,	J. Y. CRAWFORD .	. Nashville, Tenn.
1st Vice-President,	S. C. G. WATKINS .	. Mont Clair, N. J.
2d Vice-President,	THOMAS FILLEBROWN	. Boston, Mass.
Recording Secretary,	GEO. H. CUSHING .	. Chicago, Ill.
Corresponding Secretary,	EMMA EAMES CHASE	. St. Louis, Mo.
Treasurer,	HENRY W. MORGAN .	. Nashville, Tenn.

ASBURY PARK, N. J., AUGUST, 1895.

President,	J. Y. CRAWFORD .	. Nashville, Tenn.
1st Vice-President,	JAMES MCMANUS .	. Hartford, Conn.
2d Vice-President,	THOMAS FILLEBROWN	. Boston, Mass.
Recording Secretary,	GEO. H. CUSHING .	. Chicago, Ill.
Corresponding Secretary,	EMMA EAMES CHASE	. St. Louis, Mo.
Treasurer,	HENRY W. MORGAN .	. Nashville, Tenn.

*The session of 1893, owing to the holding of the World's Columbian Dental Congress, was purely formal, and by resolution was adjourned "without any election of officers, as the effect of such non-election will be, under the Constitution, to make all officers hold over." The officers elected in 1892 thus acted at the regular session of 1894.

SARATOGA SPRINGS, AUGUST, 1896.*

President,	JAMES TRUMAN . .	. Philadelphia, Pa.
1st Vice-President,	THOMAS FILLEBROWN	. Boston, Mass.
2d Vice-President,	W. R. CLIFTON . .	. Waco, Texas.
Recording Secretary,	GEO. H. CUSHING .	. Chicago, Ill.
Corresponding Secretary,	EMMA EAMES CHASE .	. St. Louis, Mo.
Treasurer,	HENRY W. MORGAN .	. Nashville, Tenn.

EXECUTIVE COMMITTEE FOR SESSION OF 1897.

J. N. CROUSE, Chairman. C. N. PEIRCE, Secretary.

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THIRD DIVISION—ON VOLUNTARY ESSAYS.

C. N. PEIRCE. S. G. PERRY. A. O. HUNT.

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* On the third day of the session of 1897, at which the officers here named served, the following resolution was adopted:

Resolved, That when this Association adjourns to-morrow it adjourn without day, delegating to the proper officers, however, the work of closing up the Association's affairs, and paying all bills essential to the same.

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BOSTON MEDICAL
AUG 19 1902
LIBRARY.

MINUTES OF TRANSACTIONS

OF THE

AMERICAN DENTAL ASSOCIATION,

SESSION OF 1897.

BY GEORGE H. CUSHING, SECRETARY.

FIRST DAY—MORNING SESSION.

THE AMERICAN DENTAL ASSOCIATION commenced its thirty-seventh annual session in the ball-room of the Chamberlin Hotel, Old Point Comfort, Va., at 11 A.M., Tuesday, August 3, 1897; the President, Dr. James Truman, in the chair.

On motion, the roll-call and the reading of the printed minutes were dispensed with.

The following were found either to be present or to have forwarded their dues:

JOINED.	NAME.	ADDRESS.
1897.	ALLEN, H. J.	421 H st., N. E., Washington, D. C.
1896.	ALLEN, THOS. M.	1929 First ave., Birmingham, Ala.
1869.	*AMBLER, H. L.	176 Euclid ave., Cleveland, Ohio.
1895.	AYERS, J. W.	208 Fayetteville st., Raleigh, N. C.
1895.	*BAKER, BOYD H.	605 King st., Wilmington, Del.
1892.	BARBER, L. L.	311 Summit st., Toledo, Ohio.
1886.	*BARNES, HENRY	106 Euclid ave., Cleveland, Ohio.
1872.	BARRETT, W. C.	208 Franklin st., Buffalo, N. Y.
1885.	*BETHEL, L. P.	Kent, Ohio.

Those marked thus (*) were not present, but sent their dues.
Those marked thus (*d*) were delegates, but not permanent members.

JOINED.	NAME.	ADDRESS.
1866.	*Bishop, J. Adams	30 W. 48th st., New York City.
1864.	*Bogue, E. A.	63 W. 48th st., New York City.
1876.	Boice, Alonzo	1612 Vine st., Philadelphia, Pa.
1895.	*Bollinger, P. S.	5th and Ludlow sts., Dayton, Ohio.
1892.	Boswell, H. H.	322 Franklin st., Buffalo, N. Y.
1873.	*Brackett, C. A.	102 Touro st., Newport, R. I.
1897.	Broomell, I. N.	302 N. 40th st., Philadelphia, Pa.
1877.	Brophy, Truman W.	1405 Champlain Bldg., Chicago, Ill.
1895.	Brown, A. J.	912 14th st., N. W., Washington, D. C.
1892.	Burkhart, H. J.	Batavia, N. Y.
1878.	Butler, C. S.	680 Main st., Buffalo, N. Y.
1863.	*Butler, C. R.	334 Euclid ave., Cleveland, Ohio.
1897.	Carr, Ellen R.	26 Pratt st., Hartford, Conn.
1895.	*Canaday, J. W.	285 State st., Albany, N. Y.
1885.	Case, C. S.	1212 Champlain Bldg., Chicago, Ill.
1874.	Cassidy, J. S.	734 Madison ave., Covington, Ky.
1890.	Chase, Emma Eames	3334 Washington ave., St. Louis, Mo.
1894.	*Chase, W. G.	1018 Witherspoon Bldg., Phila., Pa.
1871.	*Chittenden, C. C.	21 W. Main st., Madison, Wis.
1880.	*Clapp, Dwight M.	130 Commonwealth ave., Boston, Mass.
1883.	Clifton, W. R.	Waco, Texas.
1895.	Cogan, Wm. N.	1754 M st., N. W., Washington, D. C.
1869.	*Cook, C. D.	133 Pacific st., Brooklyn, N. Y.
1888.	*Conrad, Wm.	321 N. Grand ave., St. Louis, Mo.
1895.	Cowardin, L. M.	407 E. Main st., Richmond, Va.
1890.	Crawford, J. Y.	Jackson Bldg., Nashville, Tenn.
1867.	Crouse, J. N.	Room 1205, 126 State st., Chicago, Ill.
1891.	Culver, M. B.	1529 Locust st., Philadelphia, Pa.
1886.	*Curtis, G. L.	7 West 58th st., New York City.
1865.	Cushing, Geo. H.	31 Washington st., Chicago, Ill.
1888.	Custer, L. E.	28 E. 3d st., Dayton, Ohio.
1872.	*Darby, E. T.	1513 Walnut st., Philadelphia, Pa.
1880.	*Davenport, I. B.	30 Rue de l'Opera, Paris, France.
1892.	*Dewey, S. B.	29 Euclid ave., Cleveland, Ohio.
1892.	Donnally, Williams	1022 14th st., N. W., Washington, D. C.
1885.	*Douglas, B.	Cor. College and Oneida sts., Appleton, Wis.
1872.	Doyle, B. Oscar	206 W. Chestnut st., Louisville, Ky.
1895.	Dunbar, L. L.	606 Sutter st., San Francisco, Cal.
1871.	*Dunn, C. E.	921 Second st., Louisville, Ky.
1892.	*Dunn, J. Austin	901 Marshall Field Bldg., Chicago, Ill.
1897.	*d.* Eberle, Edward	307 Main st., Hartford, Conn.
1896.	*Edmunds, Nelson D.	Cor. Wood and Harrison sts., Chicago. Ill.

JOINED.	NAME.	ADDRESS.
1895.	ELLIOTT, W. ST. GEORGE	651 Madison ave., New York City.
1872.	*ESSIG, CHAS. J.	1700 Locust st., Philadelphia, Pa.
1891.	EVANS, GEORGE	49 W. 39th st., New York City.
1876.	FARRAR, J. N.	1271 Broadway, New York City.
1894.	FAUGHT, L. ASHLEY	1415 Walnut st., Philadelphia, Pa.
1864.	*FIELD, GEO. L.	Abstract Bldg., Detroit, Mich.
1876.	FILLEBROWN, THOS.	157 Newberry st., Boston, Mass.
1879.	FINLEY, M. F.	1928 I st., N. W., Washington, D. C.
1876.	FOSTER, M. W.	9 W. Franklin st., Baltimore, Md.
1896.	FRAZIER, JOHN E.	407-8 Chalefoux Bld., Birmingham, Ala.
1889.	*FREEMAN, S.	965 Madison ave., New York City.
1868.	*FREEMAN, S. A.	641 Main st., Buffalo, N. Y.
1883.	FRIEDRICHS, A. G.	155 St. Charles st., New Orleans, La.
1877.	FRIEDRICHS, G. J.	641 St. Charles st., New Orleans, La.
1878.	FULLER, A. H.	S. E. cor. 8th and Locust sts., St. Louis, Mo.
1886.	*FUNDENBERG, W. F.	Lewis Bldg., 605 Smithfield st., Pittsburg, Pa. (*Permanent without dues 1896.*)
1880.	*FUNDENBERG, W. H.	Lewis Bldg., Pittsburg, Pa.
1891.	*GASKILL, J. HOWARD	1629 Walnut st., Philadelphia, Pa.
1870.	GAYLORD, E. S.	63 Trumbull st., New Haven, Conn.
1895.	GILBERT, S. E.	1627 Columbia ave., Philadelphia, Pa.
1883.	*GILMER, THOS. L.	Room 1307, 126 State st., Chicago, Ill.
1892.	GILSON, A. H.	7 Temple Place, Boston, Mass.
1890.	*GODDARD, C. L.	406 Sutter st., San Francisco, Cal.
1895.	GOLDSMITH, S. L.	129 E. 60th st., New York City.
1895.	*GOODWIN, N. J.	275 Main st., Hartford, Conn.
1897.	GRANT, W. E.	415 W. Chestnut st., Louisville, Ky.
1896.	GREENBAUM, LEO	1435 Girard ave., Philadelphia, Pa.
1895.	*GREGORY, FRANK G.	7 W. Park st., Newark, N. J.
1890.	*GRISWOLD, W. E.	Mack Block, Denver, Col.
1895.	*GROSS, O. J.	77 Ferry st., Schenectady, N. Y.
1866.	GUILFORD, S. H.	1728 Chestnut st., Philadelphia, Pa.
1877.	*HACKER, THOS. S.	Willoughby Blk., Indianapolis, Ind.
1895.	*HALEY, META T.	West Chester, Pa.
1894.	*HARDY, C. S.	Summit, N. J.
1872.	*HARLAN, A. W.	1000 Masonic Temple, Chicago, Ill.
1895.	*HARPER, W. E.	3456 Wabash ave., Chicago, Ill.
1896.	HART, J. I.	118 W. 55th st., New York City.
1896.	*HART, R. J.	Janesville, Wis.
1896.	*HARVEY, H. T.	Trump Bldg., Battle Creek, Mich.
1865.	*HARROUN, C. H.	319 Superior st., Toledo, Ohio.
1884.	*HAWES, EARL P.	248 Weybosset st., Providence, R. I.
1885.	*HAYWARD, T. T.	Oneida Bldg., Minneapolis, Minn.

JOINED.	NAME.	ADDRESS.
1892.	*HEAD, JOS.	1415 Walnut st., Philadelphia, Pa.
1894.	*HINKINS, J. E.	Room 207, 131 53d st., Chicago, Ill.
1894.	HITCH, D. M.	3315 Baring st., Philadelphia, Pa.
1888.	*HOFF, N. S.	Ann Arbor, Mich.
1867.	*HOLMES, E. S.	103 Atlanta st., Grand Rapids, Mich. *(Permanent without dues 1892.)*
1897.	HOSFORD, W. S.	505 College Hill, Iowa City, Iowa.
1877.	*HOW, W. STORER	Chestnut st., cor. Twelfth, Philadelphia, Pa.
1879.	*HOYSRADT, G. W.	Ithaca, N. Y.
1883.	*HUNT, A. O.	1000 Masonic Temple, Chicago, Ill.
1891.	*HUNT, GEO. E.	89 East Ohio st., Indianapolis, Ind.
1876.	HUNT, R. FINLEY	1735 17th st., Washington, D. C.
1871.	*HUEY, ROBERT	330 S. 15th st., Philadelphia, Pa.
1897.	HUFFMAN, LEE F.	First National Bldg., Lexington, Ky.
1895.	*HULL, HENRY A.	Lock Box 74, New Brunswick, N. J.
1880.	*HURLBUT, J. S.	Masonic Bldg., Springfield, Mass.
1895.	*INGLIS, C. S.	251 Straight st., Paterson, N. J.
1895.	*IREDELL, HARVEY	Cor. Church and Nelson sts., New Brunswick, N. J.
1872.	*JACK, LOUIS	1533 Locust st., Philadelphia, Pa.
1892.	*JACKMAN, W. T.	106 Euclid ave., Cleveland, Ohio.
1863.	*JACKSON, H. H.	317 Jefferson ave., Detroit, Mich.
1882.	JACKSON, VICTOR H.	240 Lenox ave., New York City.
1897.	JAMESON, G. L. S.	1517 Walnut st., Philadelphia, Pa.
1884.	JEFFERIS, C. R.	908 King st., Wilmington, Del.
1886.	*JOHNSON, C. N.	Room 913, 31 Washington st., Chicago, Ill.
1894.	JOHNSON, G. E.	35 W. Washington st., Ft. Wayne, Ind.
1891.	JONES, VICTOR S.	Bethlehem, Pa.
1877.	*KEITH, H. H.	3201 Washington ave., St. Louis, Mo.
1895.	KESTERSON, R. N.	Gay and Union sts., Knoxville, Tenn.
1891.	*KIRK, E. C.	University of Pennsylvania, Philadelphia, Pa.
1856.	*KETTIG, EDWARD M.	319 W. Walnut st., Louisville, Ky.
1885.	KNAPP, J. ROLLO	620 Canal st., New Orleans, La.
1872.	*KNOWLES, SAMUEL E.	139 Post st., San Francisco, Cal.
1881.	*LITCH, W. F.	1507 Walnut st., Philadelphia, Pa.
1891.	LE ROY, LOUIS C.	6 Lexington ave., New York City.
1897.	LIPPINCOTT, J. THOS.	1427 Walnut st., Philadelphia, Pa.
1897.	LOETZERICH, JOHN D.	Pine Bluff, Ark.
1886.	LUCKEY, B. F.	182 Main st., Paterson, N. J.
1897.	LYONS, W. A.	Oxford Hotel, Washington, D. C.
1885.	MAERCKLEIN, R.	693 9th st., Milwaukee, Wis.
1885.	MARSHALL, J. S.	Room 1013, 36 Washington st., Chicago, Ill.

JOINED.	NAME.	ADDRESS.
1895.	*MAYNARD, F. J.	P. O. Box 98, Englewood, N. J.
1888.	*MENG, J. W.	Lexington, Mo.
1895.	MENGES, THEODORE	Cor. Franklin and Madison sts., Chicago, Ill.
1895.	*MILLER, HERBERT C.	408 Oregonian Bldg., Portland. Ore.
1891.	MOLYNEAUX, GRANT	S. E. cor. 7th and Elm sts., Cincinnati, Ohio.
1889.	MOORE, J. HALL	104 N. Ninth st., Richmond. Va.
1897.	MONTELL, W. A.	833 N. Eutaw st., Baltimore, Md.
1867.	*MORGAN, WM. H.	211 N. High st., Nashville, Tenn. (*Permanent without dues 1896.*)
1875.	MORGAN, HENRY W.	211 N. High st., Nashville, Tenn.
1895.	MURLLESS, FRED T., JR.	Windsor Locks, Conn.
1897.	MCBRAIR, H. C.	Middletown, N. Y.
1893.	MCFADDEN, H. B.	3505 Hamilton st., Philadelphia, Pa.
O.	MCKELLOPS, H. J.	3548 Lindell ave., St. Louis, Mo. (*Permanent without dues 1896.*)
1896.	MCLEAN, W. T.	Glenn Bldg., Cincinnati, Ohio.
1897.	MCMANUS, CHARLES	32 Pratt st., Hartford, Conn.
1892.	MCMANUS, HENRY	32 Pratt st., Hartford, Conn.
1864.	MCMANUS, JAMES	32 Pratt st., Hartford, Conn.
1889.	*M'QUILLEN, DAN'L NEALL	1628 Chestnut st., Philadelphia, Pa.
1896.	NASON, GEO. S.	446 Bee Building, Omaha, Neb.
1897.	NELSON, J. J.	330 S. 15th st., Philadelphia, Pa.
1871.	NOBLE, H. B.	1324 New York ave., Washington, D. C.
1866.	*NORTHROP, A. L.	57 W. 49th st., New York City.
1877.	*NOYES, EDMUND	1109 Stewart Building, Chicago, Ill.
1886.	OTTOFY, LOUIS	1228 Masonic Temple, Chicago, Ill.
1897.	OTTOLENGUI, R.	115 Madison ave., New York City.
1878.	*PAGE, W. E.	16 Arlington st., Boston, Mass.
O.	PALMER, CORYDON	Warren, Ohio. (*Permanent without dues 1891.*)
1863.	*PALMER, S. B.	225 S. Warren st., Syracuse, N. Y.
1883.	PATTERSON, J. D.	Keith & Perry Building, Kansas City, Mo.
1895.	*PECK, A. H.	1109 Stewart Building, Chicago, Ill.
1863.	PEIRCE, C. N.	1415 Walnut st., Philadelphia, Pa.
1880.	*PERRY, S. G.	46 W. 37th st., New York City.
1897.	PFEIFER, JOSEPHINE D.	1003 Masonic Temple, Chicago, Ill.
1897.	PRICE, W. A.	2238 Euclid ave., Cleveland, Ohio.
1885.	*PROSSER, A. J.	3901 Westminster Place, St. Louis, Mo.
1877.	*PRUYN, C. P.	Room 1312, 100 State st., Chicago, Ill.
1897.	REITZ, R. B.	Stanton, Jefferson county, Pa.
1884.	*REMINGTON, F. A.	57 W. 49th st., New York City.
1881.	RHEIN, MEYER L.	38 E. 61st st., New York City.

JOINED.	NAME.	ADDRESS.
1891.	RICH, JOHN B.	1205 G st., N. W., Washington, D. C. (*Permanent without dues 1891*).
1895.	RICHARDSON, W. E.	101 Main st., Batavia, N. Y.
1886.	*ROBERTS, NORMAN J.	Waukegan, Ill.
1887.	*ROHLAND, C. B.	123 Third st., Alton, Ill.
1896.	ROSS, A. O.	807 N. High st., Columbus, O.
1891.	*SANGER, R. M.	551 Main st., East Orange, N. J.
1888.	*SIBLEY, A. H.	1214 Filbert st., Philadelphia, Pa.
1892.	SEIP, HOWARD S.	Allentown, Pa.
1864.	*SHEPARD, L. D.	330 Dartmouth, cor. Beacon st., Boston, Mass.
1895.	*SHIELDS, NELSON T.	154 Madison ave., New York City.
1895.	SHOTWELL, F. A.	Rogersville, Tenn.
1887.	*SHRYOCK, W. W.	27 W. Berry st., Ft. Wayne, Ind.
1889.	SILL, CHARLES	301 W. 20th st., New York City.
1895.	*SISSON, H. H.	503 Fifth ave., New York City.
1889.	SMITH, B. HOLLY	1007 Madison ave., Baltimore, Md.
1872.	*SMITH, D. D.	1629 Walnut st., Philadelphia, Pa.
1880.	*SMITH, EUGENE H.	283 Dartmouth st., Boston, Mass.
O.	SMITH, H. A.	116 Garfield Place, Cincinnati, Ohio.
1892.	*SMITH, H. T.	116 Garfield Place, Cincinnati, Ohio.
1897.	SMITH, M. C.	Room 3, Lee Hall, Lynn, Mass.
1897.	SMITH, W. SCOTT	227 W. Chestnut st., Louisville, Ky.
1897.	SONNTAG, A. S.	Cleburne, Texas.
1868.	*STAINTON, C. W.	47 N. Pearl st., Buffalo, N. Y.
1886.	*STARR, A. R.	8 E. 92d st., New York City.
1870.	STELLWAGEN, THOMAS C.	1328 Chestnut st., Philadelphia, Pa.
1868.	*STRAIGHT, M. B.	80 W. Huron st., Buffalo, N. Y.
1892.	*STEPHAN, JOHN F.	29 Euclid ave., Cleveland, Ohio.
1888.	*STEVENS, B. Q.	S. E. cor. Main and Broadway, Hannibal, Mo.
1867.	*STOCKTON, C. S.	17 W. Park st., Newark, N. J.
1890.	*STUBBLEFIELD, D. R.	Wilcox Building, Nashville, Tenn.
1894.	*SUTPHIN, H. S.	24 E. Kinney st., Newark, N. J.
1873.	*SWAIN, E. D.	1109 Stewart Bldg., Chicago, Ill.
O.	TAFT, J.	Berkshire Bldg., Cincinnati, Ohio. (*Permanent without dues.*)
1896.	TALBOT, R. A.	1111 F st., Washington, D. C.
1875.	TAYLOR, L. C.	26 Pratt st., Hartford, Conn.
1867.	TEMPLETON, J. G.	435 Penn ave., Pittsburg, Pa.
1895.	TILESTON, H. B.	4th and Jefferson sts., Louisville, Ky.
1892.	*THOMAS, J. D.	1122 Walnut st., Philadelphia, Pa.
1883.	THOMPSON, A. H.	Topeka, Kansas.
1892.	*THOMPSON, HENRY C.	1113 Pennsylvania ave., Washington, D. C.
1895.	THOMPSON, J. S.	77½ Whitehall st., Atlanta, Ga.

JOINED.	NAME.	ADDRESS.
1872.	TRUMAN, JAMES	4505 Chester ave., West Philadelphia, Pa.
1896.	ULRICH, H. G.	521 N. Charles st., Baltimore, Md.
1886.	VAN DE WATER, I. N.	Madison, N. J.
1891.	*VAN VLECK, CHARLES K.	536 Warren st., Hudson, N. Y.
1897.	VERPLANCK, ROBT. I.	4 Kenmore Place, Albany, N. Y.
1884.	*WASSALL, J. W.	Suite 711, Stewart Bldg., Chicago, Ill.
1884.	*WALKER, WM. WALLACE	58 W. 50th st., New York City.
1895.	*WARREN, GEO. W.	1338 Walnut st., Philadelphia, Pa.
1876.	WATERS, T. S.	756 N. Eutaw st., Baltimore, Md.
1880.	*WATKINS, S. C. G.	Montclair, N. J.
1882.	*WENDEL, W. C.	708-9 Goldsmith Bld., Milwaukee, Wis.
1885.	*WEEKS, THOS. E.	Dayton Bldg., Minneapolis, Minn.
1895.	*WHITFIELD, GEORGE M.	215 S. Sixth st., Newark, N. J.
1885.	*WHITSLAR, W. H.	29 Euclid ave., Cleveland, Ohio.
1877.	*WILLIAMS, JACOB L.	4 Walnut st., Boston, Mass.
1880.	WILSON, GEO. H.	44 Euclid ave., Cleveland, Ohio.
1895.	WILSON, P. J.	42 Nassau st., Princeton, N. J.
1877.	*WILSON, I. P.	317 North Fourth st., Burlington, Ia.
1891.	WOLF, J. L.	1313 New York ave., Washington, D. C.
1895.	WOOLSEY, W.	1162 E. Jersey st., Elizabeth, N. J.

The letters and figures of the left-hand column in the list of members indicate the year when the member joined. O indicates an original member.

Any inaccuracies in the above list in name or location should be reported to the Treasurer at once, in order that the necessary correction may be made.

Annual dues are payable in advance. No name appears in the above list except those who have paid for 1897, and the Transactions are not sent to any who have not fully paid their dues.

Dues must be paid to the Treasurer. Send draft P. O. money order, or express order.

HENRY W. MORGAN, *Treasurer*, 211 North High st., Nashville, Tenn.

Dr. J. N. Crouse, Chairman of the Executive Committee, made a verbal report, in which he said that the Committee had mailed circulars to all Societies eligible to send Delegates,—one early in the spring, with a list of subjects which they would like to have the Societies discuss, and another one later, urging them to send Delegates to the Association. During the spring they had looked up the matter of arrangements for railroad fares, etc., for the meetings; had made arrangements with the railroads, mostly on the certificate plan, except those controlled by the Western Traffic Association. The Southern Dental Association had secured a round-trip ticket for one fare, and a railroad man would be on hand to-morrow to visé and verify certificates. Programs for the meeting had been prepared and were here as usual.

The resignation of M. L. Chaim was read and accepted.

The Publication Committee read the following report, which was referred to the Auditing Committee:

REPORT OF PUBLICATION COMMITTEE.

OLD POINT COMFORT, August 3, 1897.

The Publication Committee would respectfully submit the following report:

The Transactions were published by The S. S. White Dental Manufacturing Company, as heretofore, and in the usual admirable manner which Mr. F. L. Hise's supervision has always assured.

They were mailed to those entitled to them, including Societies, libraries, and honorary members, on January 27, 1897, and there are on hand about seventy copies.

There have been in the hands of the Chairman, ever since they were published, several hundred copies of Dr. Patrick's report on Crania; and, as copies had been sent to all Societies and individuals likely to be interested, the Committee decided to distribute those on hand to members of the profession generally, and Mr. Cornell, of the Consolidated Dental Manufacturing Company, kindly consented to send them out, and in this way they may reach some parties to whom they may prove valuable.

RECEIPTS AND EXPENDITURES.

Received:		
From Treasurer	$40.00	
" sale of Transactions	1.50	
		$41.50
Expended:		
Expressage, paper, copying, etc.	$15.35	
Rogers & Smith Co., printing, postals, and envelopes	11.50	
Postage	12.75	
The S. S. White Dental Mfg. Co., bill list of members and sections	3 00	
		42.60
Balance due Publication Committee		$1.10

GEORGE H. CUSHING, *Chairman.*

Correct.

V. H. JACKSON,
H. A. SMITH,
LOUIS OTTOFY,
} *Auditing Committee.*

The following report, which was referred to the Auditing Committee, was then read by the Treasurer:

FORTRESS MONROE, August 3, 1897.

TO THE AMERICAN DENTAL ASSOCIATION:

Balance on hand last report	$1274.28
Collected at Saratoga and since	1085.00
	$2359.28
Expended	768.94
Leaving a balance on hand	$1590.34

EXPENDITURES.

Salary of Secretary, 1896	$200.00
" " Treasurer, 1896	100.00
Paid Reporter for 1896	125.00
Printing, expressage, and postage	134.20
Account National Museum	53.95
Executive Committee, expenses Saratoga Meeting	78.59
Publication Committee	40.00
Expenses, Section I	15.00
" " II	11.20
" " IV	6.00
Refunded dues paid	5.00
	$768.94

Respectfully submitted,
HENRY W. MORGAN.

Audited and found correct, August 3, 1897.
V. H. JACKSON,
H. A. SMITH,
LOUIS OTTOFY.

The following report on the Horace Wells Memorial was then read by the Secretary:

STATEMENT OF ACCOUNT OF THE HORACE WELLS PERMANENT MEMORIAL FUND.

1897.

July 16—Amount of subscriptions to date		$1057.73
Expenses	$68.01	
Unpaid subscriptions:		
American Dental Association	250.00	
Richmond Dental Society	50.00	
Individuals	12.50	
		380.51
Amount in bank		$677.22

J. D. THOMAS, *Treasurer.*

The following Committees were then called, and all asked for further time: The Committees on National Museum, Necrology, and on Violation of the Code of Ethics.

Dr. Fillebrown, the First Vice-President, then took the chair, and the President, Dr. Truman, read his Address.

Dr. Truman, in taking his seat, unfortunately fell from the platform, but happily sustained but slight injury, and, on motion, the Association adjourned to meet at 7.30 P.M. this day.

FIRST DAY—EVENING SESSION.

The Association was called to order at 8.30 P.M.; Dr. Fillebrown, the First Vice-President, in the chair.

The minutes of the morning session were read and approved.

On motion, the President's Address was referred to a Committee of five, appointed by Dr. Fillebrown, as follows: J. D. Patterson, H. B. Noble, L. L. Dunbar, H. J. Burkhart, and Grant Molyneaux.

On motion, the Treasurer was instructed to pay all properly authenticated bills.

Section IV was called, but no report was presented. As Dr. Broomell was to present an exhibition with the stereopticon on Wednesday evening, which would come under this Section, the consideration of the Section was postponed till that time.

Section V being called and Dr. Price not being quite ready, a recurrence was had to miscellaneous business, and the report of the Corresponding Secretary was read and referred to the Auditing Committee.

REPORT OF THE CORRESPONDING SECRETARY.

AUGUST 3, 1897.

MR. PRESIDENT AND MEMBERS OF THE AMERICAN DENTAL ASSOCIATION:

The Corresponding Secretary respectfully reports:

At the request of the President, notices of this meeting were sent to each Dental Society and dental journal in the United States, calling attention to

the importance of the meeting and reminding each Society that it is entitled to representation, and asking that Delegates, properly instructed, be sent to this meeting. Blank certificates for Delegates have been mailed to all Societies requesting them.

My expenditures have been:

Printing circular-letter and envelopes	$5.75
Printing blank certificates	6.00
Postage	6.00
	$17.75

Respectfully submitted,

EMMA EAMES CHASE, *Corresponding Secretary.*

Approved.

V. H. JACKSON,
H. A. SMITH,
LOUIS OTTOFY,
} *Auditing Committee.*

The Committee on Union moved that the consideration of their report be fixed for the first business on Wednesday evening. Carried.

Section V was then again called, and Dr. Price read a paper, entitled "The Therapeutics and Phenomena of Cataphoresis." Discussed by Drs. Rhein, Custer, Cassidy, St. George Elliott, Patterson, and closed by Dr. Price.

On motion, adjourned to meet at 9 A.M. Wednesday.

SECOND DAY—MORNING SESSION.

The Association was called to order at 10 A.M.; the President in the chair.

The minutes of last evening's session were read and approved.

Under miscellaneous business a communication was read from the Southern Dental Association, inviting this body to attend their meetings and clinics, and the Secretary was instructed to acknowledge the same with a reciprocal invitation, which he duly attended to.

The Auditing Committee reported that they had examined the Treasurer's report and that of the Publication Committee, and found both correct.

The Credentials Committee submitted the following report:

REPORT OF CREDENTIALS COMMITTEE.

Academy of Stomatology of Philadelphia—J. Thomas Lippincott, James J. Nelson, I. N. Broomell.

Arkansas Dental Association—John D. Loetzerich.

Connecticut State Dental Association—Charles McManus, James McManus, Edward S. Gaylord, Ellen R. Carr.

Chicago Dental Society—Louis Ottofy, T. W. Brophy, Josephine D. Pfeifer, J. N. Crouse, George H. Cushing.

Chicago College of Dental Surgery—T. W. Brophy.

Dental Society of the State of New York—R. Ottolengui, H. C. McBrair, R. C. Verplanck.

Hartford Dental Society—Edward Eberle.

Iowa State Dental Society—W. S. Hosford.

Kentucky State Dental Association.—W. E. Grant, Lee F. Huffman, W. Scott Smith.

Louisiana State Dental Society—Andrew G. Friedrichs.

Missouri Dental College, Dental Department of Washington University—Albert H. Fuller.

Maryland State Dental Association—William A. Montell.

Massachusetts State Dental Society—M. C. Smith.

New Orleans Stomatological Society—A. G. Friedrichs.

Ohio State Dental Society—W. A. Price.

Pennsylvania State Dental Society—G. L. S. Jameson.

Pennsylvania College of Dental Surgery—C. N. Peirce.

Pittsburg Dental College—J. G. Templeton.

Society of the Alumni, Department of Dentistry, University of Pennsylvania—Ralph B. Reitz.

Texas Dental Association—A. F. Sonntag.

Vanderbilt University, Dental Department—H. W. Morgan.

Washington City Dental Society—M. F. Finley, W. N. Cogan, W. A. Lyon, Williams Donnally, R. W. Talbott, H. B. Noble, R. Finley Hunt, H. J. Allen.

Wisconsin State Dental Society—R. E. Maercklein.

The Committee on Ethics submitted the following report, which was adopted:

At the last annual meeting charges of unprofessional conduct were preferred against Dr. W. P. Horton, a member of this Association.

Dr. Horton having received notice of these charges through publication

in the Transactions, and having made no defence, your Committee recommend that Dr. W. P. Horton's name be dropped from the roll of membership.

The regular order now called for Dr. Harlan's annual address. He not being present, nor his paper, on motion, Dr. Cassidy read his annual address, entitled "Relations of Chemistry to Dentistry," which was discussed by Drs. Barrett, Peirce, St. George Elliott, Cassidy, Taft, H. A. Smith, and Patterson.

On motion, the subject was passed.

On motion, Section I was called, in order to hear Dr. Case's paper, entitled "Principles of Force and Anchorage in the Movement of Teeth."

Dr. Case then read his paper. Discussed by Drs. V. H. Jackson, Noble, McKellops, Rich, and Ottolengui.

At this point, the hour for the organization of Sections having arrived, on motion it was decided to continue the discussion of this paper one-half hour. The discussion was continued by Drs. Guilford and Molyneaux, and closed by Dr. Case.

Adjourned, to meet at 7.30 P.M.

SECOND DAY—EVENING SESSION.

The Association was called to order at 8.30 P.M.; the President in the chair.

The minutes of the morning session were read and approved.

Dr. Richards, President of the Southern Dental Association, being present, he was invited to a seat beside the President, on motion of Dr. Fillebrown.

Under miscellaneous business, the Committee on Union being called, Dr. Noel, Chairman of the Committee of the Southern Association, was asked to make some remarks.

Dr. Noel said that he was happy to be able to say that the movement to unite the two Associations was progressing favorably, and now only awaited the action of this body. In the Southern Dental Association we were unanimous for the movement. When the vote was taken on adopting the report of the Committee there was only one dissenting voice, but the gentleman afterward stated that he did not know what he was voting on at the time.

Dr. Fillebrown then read the report:

Your Committee appointed to promote the union of the American Dental Association with the Southern Dental Association have attended to their duty, and beg leave to make the following report:

The union of the two Associations seems to them a desirable object to be attained. They have held several meetings in conference with the Committee of the Southern Association, and have agreed upon the following points in common, to incorporate in their reports:

They desire to favorably recommend the union of the Associations upon the following basis:

First. Providing a new Association, with a new name.

Second. Assuring membership in the new Association of all the present members of the Southern and American Associations.

Third. Providing for organization of branches in the several divisions, to be formed by the members residing in that division. One of these divisions would be composed of the Southern Association, thus preserving its organization and its history.

Fourth. That the meetings shall be held in each division in rotation.

Fifth. That the President shall be chosen from the section in which the meeting is being held.

The Committee recommend that this Association meet in convention at some convenient time, to consider the subject of union.

(Signed) THOMAS FILLEBROWN,
B. HOLLY SMITH,
J. Y. CRAWFORD,
J. N. CROUSE.

The following was adopted:

Moved, That the Committee on Union be requested to arrange for a convention of the members of the two Associations to consider this subject.

The Committee on President's Address offered its report.

On motion, its consideration was made the special order the first thing to-morrow morning.

The following Committee was appointed to examine the books of the Dental Protective Association: J. D. Patterson, W. H. Richards, and H. B. Noble.

On motion, the Association voted to adjourn to-morrow at 12.30 to join in convention with the Southern Dental Association for the formation of a new organization.

Section IV was called, and the report of the Secretary of the Section was read by the Secretary of the Association, after which Dr. Broomell read his paper, entitled "Macroscopic Tooth-Development," illustrated by means of the stereopticon, at the close of which a vote of thanks was tendered to the author.

On motion, adjourned to 9 A.M. to-morrow.

THIRD DAY—MORNING SESSION.

The Association was called to order at 10 A.M.; the President in the chair.

The minutes of last evening's session were read and approved.

Under miscellaneous business, the Committee on Necrology read its report, which will be found in the memorial pages.

The report on the President's Address was called and postponed till some future time.

The paper of Dr. Broomell was then discussed by Dr. Peirce and the subject passed.

Section VI being called, the Chairman, Dr. Patterson, read the report.

The rules were here suspended, and Section I was again passed temporarily in order to hear the report of Section VII.

The Chairman, Dr. Barrett, made a verbal report, asking permission to file a written one later, which permission was granted.

He announced the following papers from his Section: "Structural Development," by C. N. Peirce; "The Teeth as a Factor in Anthropology," by Charles H. Ward; "Further Studies of the Relations of the Frontal Sinus to the Antrum," by Thomas Fillebrown; "Report of a Case in Practice—Operation for Opening the Frontal Sinus and the Infundibulum," by T. W. Brophy.

On motion, the papers of Drs. Ward and Fillebrown were ordered read by title and referred to the Publication Committee.

Dr. Peirce and Dr. Brophy then read their papers.

Section I was called again, and Dr. M. F. Finley, of Washington, read a paper, entitled "Opening the Bite with Cap Fillings without Destroying the Vitality of the Pulp."

Discussion on Section VI was then participated in by Drs. Peirce, Barrett, Taft, and closed by Dr. Patterson.

The report of the Committee to examine the books of the Dental Protective Association was then read, as follows:

We, the undersigned, have examined the accounts of the Dental Protective Association, and find the same to be correct.

(Signed) J. D. PATTERSON, H. B. NOBLE, W. H. RICHARDS, } *Auditing Committee.*

August 5, 1897.

All members were requested to go to the convention at the Hygeia at 12.30.

Adjourned to meet at 7.30 P.M.

THIRD DAY—EVENING SESSION.

The minutes of the morning session were read and approved.

Under miscellaneous business, the Executive Committee made a verbal report through its Secretary, Dr. Peirce.

Dr. Peirce said that the supposition is that this Association

will terminate its existence with this session, and there are several matters which the Committee wish to bring to the attention of the members.

The first is the publication of the Transactions. He moved that the proceedings be referred to the Publication Committee, to be published as usual. So ordered.

The second is that the Secretary has on hand a number of copies of the Transactions of previous meetings. What shall be done with them? It seems desirable that we should keep a certain number of our Transactions.

Dr. Donnally said that the National Museum and Library will take care of anything of that sort, and take care of it as desired; will either keep the Transactions, if sent to them, and put them on their shelves, or distribute them as instructed.

Dr. Peirce then moved that the copies be placed in the care of the National Dental Museum and Library, and that an order on the Treasurer be drawn for the expense of that distribution.

Dr. Peirce thought that at least one copy should be kept on the shelves.

Dr. Fillebrown said that the Library would take care of that. He offered the following resolution as a substitute for the motion of Dr. Peirce, and it was adopted:

Resolved, That any surplus books or specimens which the Association may have for disposal be given to the Army Medical Museum and Library, to be used for the best interests of mankind.

Dr. Peirce moved that the old record, from the foundation of the Association, containing the original Constitution and the signatures of all members who have joined, to which the names of all members now present shall be added, with the date of their entrance, should be rebound and be deposited in the National Museum and Library. So ordered.

Dr. Peirce then said that the next question was as to the funds of this Association.

The President thought that the first business was to decide on what is to be done with the Association.

The following was presented by Dr. Crouse:

Resolved, That when this Association adjourns to-morrow it adjourn without day, delegating to the proper officers, however, the work of closing up the Association's affairs, and paying all bills essential to the same.

This was discussed by Drs. Truman, Taft, Crouse, Fillebrown, Patterson, H. A. Smith, Ottofy, and Crawford, and was then adopted.

On motion of Dr. Fillebrown, it was ordered that any residue of funds of the Association after the payment of all obligations be paid over to the Dental Protective Association.

It was also ordered that the Treasurer of the American Dental Association pay into the Treasury of the National Dental Association a sum equal to one dollar for every permanent member of the American Dental Association whose dues shall be paid in full up to and including this session.

The report on the National Dental Museum and Library was read by Dr. Donnally, Chairman of the Committee, as follows:

OLD POINT COMFORT, Va., August 5, 1897.

TO THE AMERICAN DENTAL ASSOCIATION:

Your Committee on National Dental Museum and Library beg leave to report that *this* interest of the profession is being well cared for by the Army Medical Museum and Library, that great institution, now generally recognized by the medical and dental professions as their National Collections of Literature and Museum Specimens.

Under the system of this institution the current literature in various languages relating to the several branches of the healing art is collected from all parts of the world and made available for the use of colleges, societies, and individual investigators throughout the United States. The more use the professions and the schools make of this great storehouse of knowledge the more will its efficiency and capacity be increased and the more liberal will be the appropriations of Congress for its enlargement. The Medical Department of Johns Hopkins University realized from the first the immense value of this library, made its close proximity thereto a drawing-card in its announcements, and gave their students the full benefit of its free use. Every college, Society, and individual in the land has the same privilege and the same advantages, with the one exception of proximity.

The system by which the Museum is built up is, of necessity, different and less definite in results. This department is necessarily dependent, to a great extent, upon voluntary contributions of those engaged in different lines of practice, except as to the army surgeons, who are required to supply promptly everything of value afforded by their practice. There is, however, a growing interest on the part of teachers and specialists, and the number of intelligent visitors from the States has recently increased from 5000 to about 10,000 a month.

Your Committee has attempted, with partially satisfactory results, to assist the management in collecting material relating to the every-day practical work of dentists. No other branch of the healing art can so well demonstrate by means of models, charts, etc., the methods and results of its practical work, yet the collection, during the two years that the dental section has received the special favor and attention of the management, is incomplete as to every particular subject, though the Jackson system of regulating has recently been illustrated by about one hundred and seventy painted and gilded plaster duplicates of typical cases. The free services of Dr. Jackson and your Committee reduced the cost to a very much lower figure than the department could have had the work done for. We have the promise of the free gift of several private collections, including Flagg's, Bonwill's, and Farrar's.

Your Committee has had printed and distributed to the colleges, journals, and members of the profession about 7000 circulars relating to the Museum and Library, two-thirds the expense thereof being borne by the department and one-third by this Association. A bill of forty dollars, approved by this Committee, is herewith submitted. No further expense to this body is now, nor likely to become, necessary, the liberal appropriations of Congress being ample to meet all proper expense of building a complete collection of everything desirable pertaining to dentistry.

The disposition of the management and of those devoted to the scientific work to favor dentistry equally with other specialties is all that could be desired, but their eminent ability in such subjects as general pathology, histology, bacteriology, etc., could not, without special training, become available to advance the present condition of these sciences in their special application to dentistry. The needs of dentistry in this respect could be met by a few well-qualified persons pursuing the scientific subjects of dentistry, if such persons were supplied with ample facilities and freed from the exigencies of private practice. This department of the National Government freely offers ample facilities and equipment, and only the necessity of continuing private practice for a livelihood forbids acceptance. It is the opinion of your Committee that we could remove this latter obstacle and provide a way to place under this department, at government expense, some dentist of acknowledged fitness to pursue the scientific aspect of certain subjects of dentistry. If this suggestion meets your approval, we recommend the adoption of the following:

Resolved, That the Committee on National Dental Museum and Library be authorized by this Association to seek, in the interest of public health,

the employment, at government expense, in the Army Medical Museum and Library, of at least one dentist of eminent fitness, whose time, when so employed, shall be devoted exclusively to the advancement of dental science.

Respectfully submitted,

WMS. DONNALLY, *Chairman*,
J. TAFT,
HENRY W. MORGAN,
Committee on National Dental Museum and Library.

The report and resolution were adopted.

Section II asked leave to file its report without reading.

The Committee on Nomenclature offered its report to be filed and referred to the Publication Committee.

Section III was called, and Dr. Crouse made a verbal report and statement of experiments with amalgam.

The further consideration of the subject was postponed till 10 A.M., Friday.

On motion, adjourned.

FOURTH DAY—MORNING SESSION.

The Association was called to order at 10.30 A.M.; the President in the chair.

The minutes of the evening session were read and approved.

Under the head of miscellaneous business, it was resolved that the Transactions of this session be published as usual, and that the Transactions of the National Dental Association be published as supplemental in the same volume.

The following was adopted:

Resolved, That the present Auditing Committee are authorized to audit and publish all accounts after the final settlement of the affairs of this Association.

The discussion on amalgam was continued by Drs. Patterson, Taft, Custer, Peirce, and closed by Dr. Crouse.

Miscellaneous business was again taken up.

On motion, it was requested that all permanent members present at the final adjournment sign their names in the book provided, and that Drs. J. Taft and H. A. Smith, the only members now in attendance who were present at the organization of this Association, sign their names after all the others.

A vote of thanks was extended to the Chamberlin Hotel for courtesy and kind treatment.

The following members then made remarks in view of the passing away of the Association:

DR. TAFT: Mr. President, I hope you will indulge a remark or two in reference to the occasion that is now upon us, and the fact that but four of those present to-day were present at the organization of this body. A number of those who were present at that time have passed away. Others still remain, but are not with us to-day. When I look back to that occasion it produces a feeling of sadness, that the career of a body that has accomplished so much as this has now terminates by the inevitable trend of the times and of circumstances in the profession,—circumstances all right enough, perhaps; but to those who have been long years with it, and especially to those who were at the inauguration of it, it produces more or less of a feeling of sadness that associations which we have had as members of this body are to cease forever in the capacity in which they have existed heretofore. It is not unreasonable that these feelings should be indulged. Indeed, they come, and cannot be avoided by some of us at least. That is not produced, however, by any other consideration than that which has passed away. This Association has accomplished a grand work for the profession in this country. Its influence reached out, not only to the profession in this country, but to the profession in all civilized countries of the world. It has striven for the improvement, for the betterment, for the elevation of the profession; and when we compare the state of the profession at the origin of this body with what it now is, we can fully realize that fact. The profession does stand to-day in a vastly advanced

position over that of a third of a century ago. This is not wholly, but it is largely, due to the work that has been done in and by this Association. You know what it has done in the way of promoting the organization of State and local societies. You know what it has done in its influence upon the literature of our profession. You know full well the influence it has had upon our educational institutions. You know it has fostered all these departments, and they *do* owe much of their progress and prosperity to this organization. They have all been stimulated and encouraged through the influence of this body. It has done great good. Let us bear this in mind. It is to be hoped that the memory of the American Dental Association will not pass from the minds of any who have co-operated in the work which it has so nobly done, but that its career will be held sacred in the memory of all its members. It is true that it has had its ups and downs, but it has steered well through all the difficulties which it has encountered, and it has come to a grand end; and that into which it is to be merged will, I trust, go on in years to come and be as efficient, as honorable, and as well directed in all it does in future years, as this body has in the past. (Applause.)

DR. CORYDON PALMER: I was present at the time of the preliminary meeting for the formation of the American Dental Association, which took place at Niagara Falls, and with Dr. McQuillen, of Philadelphia, and Dr. Allport, of Chicago, I was one of the first to labor for and urge its formation. The first regular meeting was held in the city of Washington, D. C., and the second in the city of Cleveland, Ohio; the latter adjourned to meet in the city of Philadelphia the following year. Dr. C. R. Butler, of Cleveland, Ohio, and myself were appointed delegates from the Northern Ohio Dental Association to attend the meeting, which we did, and from that time on I have been a constant member. At a meeting held at Saratoga, August, 1868, I was awarded by unanimous consent the field in dentistry of artistic design, which I have since endeavored to faithfully keep. I feel proud to have been one to have the privilege of contributing to the promotion of one of the most useful and advanced institutions of modern times; and now, with a feeling of sadness that the loved American Dental Association must pass and be no more, I have the hope that when merged into the contemplated new organization, to be known as the National

Dental Association, it may still hold its proud position of one of the first institutions of human progress.

DR. MCMANUS: Mr. President, ladies, and gentlemen, two years ago, in New England, two societies, one of which had, I think, been in existence thirty-three years, and the other thirty-two, came together and voted to disband and form a district association in New England. One of these societies was called the New England Society, and the other the Connecticut Valley. I was a member of the Connecticut Valley from the first year. I was not what you would call a charter member, but I came in after the organization. A few of us felt as Dr. Taft and Dr. Palmer feel to-day. We felt quite sad at the disbanding of those old societies. But both of them had voted to do it, and to form this district organization, to be called the Northeastern Association. How that Association will prosper time will tell; but it was a movement in the direction of trying to strengthen State societies, and still have an organization where the members of the State societies would meet together in a union meeting, still keeping up their friendly relations, and, in addition to that, try to work up an interest in the State societies and add to the membership of the National Association. At that time many of us did not think that what has been accomplished here would be accomplished. We believed at that time that the American Association would go on, and that the Southern Association would go on. But that has been changed. So I have been gradually brought to see that the present movement is probably a proper one, and I do not feel quite as badly on this occasion over the change as I did when we made our change up there.

I want to say that it is over thirty years since Professor Taft came into New England to awaken an interest in dental organizations. I think likely he has forgotten it, but he looks as young now as he did then, and a few of us remember with great pleasure his visit to Connecticut with Dr. Atkinson. I think they went into Massachusetts and some other States at that time. Their presence stimulated the dentists of New England, and we started good organizations. I think New England has always felt grateful for that visit. I think this change here has been very successfully accomplished, and I have great reason to hope that the National Association will do even a greater work than the Ameri-

can has done in the past. But if it only goes on in the same way in which the American Association has done, if it will do as much in the future as the American has done in the past, it will have glory enough.

As for myself personally, I wish to say that the members of the American Association have been exceedingly kind to me. As far back as 1865 they honored me with an election to the Vice-Presidency. They did so again a few years ago, and I came on to this meeting in the hope that I had had my share and would receive no more offices. But unfortunately, they have piled it on by electing me again as one of the Vice-Presidents. I wish to thank all the old members of the Association. I know they did it from a kindly feeling toward me, because I had been so long a member; but I was wholly unprepared for the kindly feeling and the generous way in which I was treated, not only by this Association, but by the Southern. (Applause.)

DR. TAFT: I wish to make an explanation, lest a wrong impression be created. The visit throughout the East, which was referred to by Dr. McManus, was not Dr. Atkinson's work or my work; it was the work of this Association. We went simply as sent forth by this body to do certain work. We did the best we could, and if any good was accomplished, it is a matter of great gratification to me. I wish simply to disclaim any credit for that work, because it was the work of this body, and the credit belongs to it. It originated at the time I mentioned, when this body had a fostering care over association work throughout the country.

DR. H. A. SMITH: Mr. President, I have been a society man from the beginning. On the day I received my degree I joined the old Mississippi Valley Association, and was a member of that body until its dissolution within a few months. I have often said that if my relation with dental associations had been cut out of my life my career as a dentist would have been largely blank; nothing but drudgery and hard work. It has been this meeting with my fellows two or three times a year that has stimulated me and made me glad that I am a dentist. I came into this Association early, as a very young man, and I have been regular in attendance, having, I think, only missed one meeting; and I must say that to me my connection with it has been almost invaluable. Speaking from the social point of view, I think, and I say it boldly,

that the members of dental associations are the best fellows alive. It seems to me they have no equals. They are cultured to a high degree, and they have the social element, all those qualities we prize in one who is known as a good fellow. I never enjoy myself so much as I do when I am with dentists, except in my own family. For that reason, my relation with these associations has been of immense pleasure to me, and immense value as well. Then take the professional side of it. Think of meeting such men as we have year after year in this Association, men who have reached the highest attainments in dentistry, who give forth their best experiences. We grow in spite of ourselves under such influences, and I say from that standpoint it has been of very great value to me. Now, when this Association goes out of existence, of course we feel many regrets; and yet I believe the old animating spirit has gone into the new body, and that we shall go on to higher efforts in the elevation of the profession in an educational way, in the science and practice of the profession as well as in a social way. (Applause.)

DR. CROUSE: Mr. President, I remember very well the first meeting of the American Dental Association, which I attended when I was a mere boy, about seventeen years old. I had been to Philadelphia and attended a short course in dentistry,—the regular course then,—had gone home and into partnership with the man with whom I commenced studying, and thought I was a dentist. A call came to the office, signed by Dr. Cushing and some others in Chicago, for the formation of a State Society. The American Dental Association met that year in Chicago, and I went to the meeting. There was some entertainment to be given, and members and delegates were asked to get their tickets. I got a ticket the same as the rest, although neither a delegate nor a member, but a mere looker-on. I remember seeing Dr. Taft and Dr. Atkinson, and somebody else, a talkative man, who built out a corner on a front tooth, which was a marvel to me. After seeing that, I concluded I was not a dentist at all. I was very quick to discover that, which is more than some people ever discover, and it was a very good thing for me. (Laughter.) After that I used to go to the meetings of the American Dental Association as a kind of looker-on, and criticised the doings in my own mind. I thought it did not amount to much, and I would say to Dr. Dean

and Dr. Cushing, "I am not going next year; it is no good." I felt that way until I got into the work. And that is the point I wish to make. At the Centennial at Philadelphia somebody put me on the Executive Committee, and I have been a member of that Committee every year since, except one, when I got mad and resigned. This is what I wish to emphasize: That if you expect to enjoy any society, or anything that you are in, get to work. The fellows who do nothing get no good from a society. It is the men who work that obtain the benefit. So that is the plea I would make for membership in an association. Do something at home for it, and when you come here do something. The good which this Association has been to me cannot be estimated. To this and our State Society I owe anything I am in the profession. (Applause.)

It was the influence of the American Dental Association which caused the dentists of our State to form the Illinois State Association, so they could have delegates, if nothing else. So it reaches out, and we cannot calculate the good it has done.

DR. PEIRCE: I simply wish to add a word, to bring to memory a former friend and active member from Philadelphia. My late friend, Dr. J. H. McQuillen, probably was as instrumental as any other one man in forming this Association. I remember several conversations I had with him on the subject, and the deep interest he took in it. He was at the preliminary meeting at Niagara Falls, and then at the subsequent meeting at Washington, when this Association was organized.

DR. TAFT: It was organized at Niagara Falls; that was the initiation, and the next year it met at Washington, and the next year at Cleveland. After that I think it met at Philadelphia.

DR. PEIRCE: To Dr. McQuillen first, and then to Dr. M. S. Dean, of Chicago, I feel that we owe more than to any other two men; to Dr. McQuillen especially in its organization, and to Dr. Dean in carrying on the work and getting it into a good, healthy condition. What I gained through the Association for the first three or four years I gained through the influence of Dr. M. S. Dean. He was not a fluent speaker, and did not often take the floor, but he was a good worker. I think what has been the influence upon myself has been the influence upon many others, namely: to encourage them to do original work, and to formulate

their ideas and bring them to the Association, where they were fully appreciated. So I do not think we can estimate the influence of this Association upon the dental profession of this country. (Applause.)

DR. FILLEBROWN: Though not an original member and not a constant attendant at the meetings until during the past twenty years, I feel as much interest in this Association as any one can. I feel, as does Dr. Crouse, that my greatest professional happiness has been experienced since I became a worker in this Association, and I fully agree with him that to be a worker is the only way to enjoy a society. We know the "seed is not quickened except it die," and we know, too, that the evolution of the higher is not realized except by the extinction of the lower. Progress is built upon the ruins of the past. All through the history of the world we find that institutions have arisen, races and peoples have appeared, done their work, and then disappeared from the face of the earth. The world goes on, new circumstances arise, which make it impossible for former agencies to do the work demanded.

The American Dental Association has to-day arrived at that point. It has done a noble work well, but there is now a work to be done which it cannot do. It can only be done by the formation of a new Association. Happily that has been consummated, and now this Association cheerfully lays its mantle upon the shoulders of the National Dental Association and bids it God-speed. Our good brother, Dr. H. A. Smith, says the spirit of this Association passes into the new organization. I would add that not only the spirit but the spirits (applause)—each individual spirit—goes into the new Association, to join with other kindred spirits to give it life and strength. This is, to me, the happiest feature of the occasion, that in the giving up of this organization the same individuality, the same motive, the same enthusiasm, and the same culture join with that from all over the country, and come together into one strong body, forming one strong union, which shall carry it on to greater perfection. May the new organization live long and continue the work so well done by this society. The future will not fail to recognize the American Dental Association as the basis which has made the existence of the new possible. (Applause.)

DR. TAFT: Mr. President, I trust it will come into the mind and intent of somebody to prepare a condensed history of the American Dental Association, and to publish it. It need cover but a few pages, but should embrace the names of those who have been the leading actors in its work, especially those who have passed away, and embracing the principal acts and the leading work accomplished by the society, merely for future reference and the gratification of the members, and so on. Its history, of course, can be gathered from its publications, from its Transactions; and it seems to me that such a condensed history is eminently due to the old Association.

DR. PATTERSON: When I first came to this Association, some fourteen or fifteen years ago, as a delegate from the Kansas State Dental Association, to the meeting at Niagara, what impressed me then, and has since impressed me, was the cordiality with which I was, and always have been, received. I remember the remark of good old Dr. Keeley, who was the Treasurer then, who said, "Ah, all the way from Kansas! Glad to see you." I also remember the greeting of the Vice-President, Dr. Friedrichs, of New Orleans, who was, I think, presiding in the place of Dr. Goddard, who had died during that year. I remember also Dr. Rehwinkel, Dr. Taft, Dr. Kingsley, Dr. Barrett, Dr. Smith, Dr. Allport, and others. Some of these things have remained in my memory. I never saw the Atlantic Ocean until that summer, and I always remember the first meeting of the American Dental Association which I attended along with that. I wish to say that since that time the kindness that I have received from members has been more than my desert. In my weak way I have tried to make some return for your extreme kindness. It seems to me that the reputation of the American Dental Association is safe in the hearts of all its members. The work which it has done will not be forgotten. Its memory is perfectly safe and assured, and we are all glad that it is so. (Applause.)

DR. CUSHING: Mr. President, I cannot let this occasion go by without saying one word. At first I thought I would not say anything, and yet it seems to me appropriate that I should add a few words to what has been said. For nearly twenty years, through the partiality of the members of the Association, I have sat at this desk. I have seen the members as perhaps nobody

else has seen them, constantly before me as they came and went. I recall the old friends who have gone away from us. Every year, as I take my place here, I miss them; have missed them constantly, and shall continue to miss them, and it is with inexpressible sadness that I realize that this is the last gathering of this body as such. I am not in any mood to make a speech, if I were able. I feel that we are very much in the position of those who stand at the death-bed of a dear friend, who feel confident he has gone to a higher life, but whose passing away leaves an aching void.

DR. TAFT: I move that the thanks of the Association be tendered to the officers of the Association, and especially to our worthy Secretary, who has served this body so long and so faithfully, and to whom great credit is due for the work he has accomplished in this direction.

DR. PEIRCE: Mr. President, I second that motion with a great deal of pleasure.

The motion was unanimously adopted.

The PRESIDENT: If there are no further remarks, the Secretary will now read the closing minutes, after which I shall close up this Association.

The Secretary read the minutes of the session, which were approved.

The PRESIDENT (Dr. Truman): Members of the American Dental Association, since the time when Dr. Allport began his duties as the first President of this Association, no presiding officer has had a more trying duty to perform than that which now devolves upon me. When I left my home to come to this meeting, it was with a joyous feeling that we should unite with our Southern brethren to form a new Association, and that has been accomplished. I only regret that those who had that reorganization in charge failed to read the signs of the present and future; failed to see, as I stated in my annual address, that if they did not heed those signs that future would destroy their work. Now, I do not propose to criticise the proceedings here, but I wish to express my profound regret that they could not see their way clear to make some arrangement by which scientific workers should be drawn out of their cloisters, be protected in our Association, and enabled to live without being compelled to struggle for daily bread. Further than that, I regret that they also did not

see their way clear to do away with that, to my mind, poisonous element in associated effort,—permanent membership. I look forward hopefully, however, to the time when I believe that will be accomplished.

I have one more regret,—that this American Dental Association should have been left to die as it is dying to-day. This Association should have lived. There was no reason why it should not survive. It could have been made a branch. You have now before you the necessity of reorganizing a body whose membership shall be in the eastern part of this continent.

We bring our wreaths and our mourning garments for our dead loves. All of those here have perhaps passed through the ordinary trials of life. You have assembled here at this hour to bury this Association. You have prepared its tomb in the Army Medical Museum; but as we pass away from this hall we must sadly remember that we shall meet no more under the name of the American Dental Association. Let us return to our homes feeling that the future will care for itself; that the profession of dentistry is worthy of our best efforts; that as long as we live we will stand by any organization that may be established, hopefully looking to it always for progress and improvement.

I have had no more painful duty than this. I have lived with this Association for many years, and have met with you, socially and professionally. Now we shall meet no more upon this platform and under the old name, and this Association is disbanded forever. There being nothing further, I declare this, the final, meeting of the American Dental Association adjourned without day.

GEORGE H. CUSHING, *Secretary.*

REPORT ON NECROLOGY.

The year just closed has been a remarkable one in regard to the number of prominent members of the dental profession who have been removed by death, and especially has it been remarkable in the passing away of so many of the prominent members of this Association, five having died within the last twelve months. With one exception, this is unprecedented in the history of this body.

It is eminently fitting that we should place upon its records some token of the high esteem entertained for them by this Association.

FRANK ABBOTT, M.D.

Dr. Frank Abbott, of New York, suddenly passed away April 20, 1897, of cardiac disease, in the sixty-first year of his age.

Dr. Abbott was a native of Shapleigh, York county, Me. He was a member of a prominent and well-known family of New England. He entered upon the practice of dentistry at Johnstown, N. Y., in 1858, where he remained for several years. He went into the Union Army during the Civil War, in which he took a responsible part, and was finally taken prisoner. Being subsequently released, he returned to his home and quietly resumed his professional life. After a brief time he removed to New York City, where he established a large practice.

He was actively instrumental in establishing the New York College of Dentistry, in which he served as Dean until the time of his death.

Dr. Abbott was one of the very active members of his profession, interested in all things that tended to promote its welfare. As an organizer and teacher he had a national reputation. He was a writer and author of more than ordinary ability. The numerous papers he read before this body are ample evidence of

this fact. He prepared a work, entitled "Dental Pathology and Practice," in which the choicest of these productions are to be found.

He was greatly interested in dental association work.

He became a member of this body in July, 1866, and was ever active in promoting its best interests, being always present at the annual meetings, and he was equally active in dental society work in his own State.

He was a member of the National Association of Dental Faculties from its organization to the time of his death, and was for many years a member of the Executive Committee of that body, and during those years especially did as much in shaping its policy as any other member.

Dr. Abbott was enthusiastic in whatever he undertook; ever ready to give expression to his views. He was most genial and kind-hearted, and was highly esteemed by his professional *confrères.*

FRANCIS PEABODY, D.D.S.

Dr. Peabody was born in Boston, Mass., January 22, 1833. In his early manhood he removed to Louisville, Ky., where he studied his profession with his uncle, the late W. H. Goddard, one of the most distinguished dentists of that city in his day. After his pupilage with Dr. Goddard he took a course of instruction in the Ohio College of Dental Surgery, graduating from that institution. He began the practice of dentistry in Louisville, continuing there till 1871, when he went to Brazil and practiced several years in Rio Janeiro, after which he returned to Louisville, where he remained until his death.

Dr. Peabody was one of the best known dentists in Kentucky. He early in his professional career allied himself with dental society work, and was earnest and effective in his efforts to elevate the profession.

He was one of the organizers of the Kentucky State Dental Association, a very active member of the Southern and of many other societies. He became a member of this body in 1888, and has ever been interested in its work, and was present at its meetings when his health would permit.

For some years before his death he was connected with the Louisville Dental College as President of its Faculty and Professor of Operative Dentistry. He was a successful teacher, and did much to build up and strengthen that institution.

A man of marked ability as a practitioner, he was fruitful in devices and methods in practice, a man of generous disposition and kindly heart, whose friendship every one prized.

S. B. BROWN, D.D.S.

Dr. Seneca Buell Brown, of Fort Wayne, Ind., was born August 11, 1834, at Marlboro, Windom county, Vt., and died January 5, 1897. Dr. Brown grew up in agricultural pursuits. His education was obtained in the main at Westminister Academy, Vt.

After two years of pupilage as a student of dentistry he, on January 31, 1854, commenced practice at Ticonderoga, N. Y. In 1855 he removed to Piqua, Ohio, and in 1869 to Fort Wayne, where he practiced till his death.

Dr. Brown received the degree of D.D.S. from the Pennsylvania College of Dental Surgery in March, 1870.

He was ever much interested in all that pertained to his chosen profession. He was a stalwart champion of its honor and dignity, ever ready to come to its defence whenever and wherever it was assailed. His appreciation of the dignity and honor of the profession is worthy of universal emulation. During the last two or three years of his life he did much to bring his views upon this subject to the attention of college classes throughout the country by addresses and written communications. He became a member of this body August, 1869, and was usually present at its meetings.

Dr. Brown was of a quiet and rather retiring nature, and perhaps exerted more influence upon his professional brethren by personal contact than by more public efforts; still, whenever occasion called for it he was not lacking in the latter.

Though he was widely known in professional circles of the country, his most marked influence was exercised within the bounds of his own State. He was one of the founders of the Indiana State Dental Society, occupying its highest positions of

trust and honor. For several years he was a member of the Board of Dental Examiners of the State, and was connected with the Indiana Dental College, either as a teacher or a member of its faculty, nearly all the years of its existence.

Who, in Indiana, will fill Dr. Brown's place?

He was greatly beloved, and his memory will be warmly cherished by all who knew him.

ELI SLEGEL, D.D.S.

Dr. Slegel was born November 23, 1836, at Fleetwood, Pa., being reared on a farm.

He began the study of dentistry at Coatesville, Chester county, Pa., under Dr. W. W. Thompson, and completed his course of study under Dr. Lukens, of Philadelphia. He commenced practice in Reading, Pa., in March, 1857. He allied himself with dental societies in his own State, always attending so far as he might to their welfare, and became an active member of this body in 1896.

Dr. Slegel was a persistent student, and added many useful improvements to his art, which were highly prized by those to whom they were given.

He possessed a disposition and bearing that commanded the respect of all who came in contact with him, professionally or otherwise.

He was kind-hearted and of a genial disposition, and was ever ready to relieve suffering humanity, forgetful of self. His loss will be greatly felt.

WILLIAM N. MORRISON, D.D.S.

Dr. Morrison's death occurred at Hot Springs, Ark., December 20, 1896. He was born at East Springfield, Ohio, May 25, 1842. His whole professional life was spent in St. Louis, Mo., where he established an eminently successful practice. In his early life he had to contend against great odds, and especially when he came to take up his life-work, but he had great energy, perseverance, and industry.

He graduated from the Ohio College of Dental Surgery in 1864.

Throughout his professional career he kept fully abreast with the progress of his profession. He was the first to devise, use, and present to the profession several valuable methods and processes, and his interest in his profession never flagged.

He was ever ready to receive that which was valuable from others, and equally ready to give that which he possessed that might be serviceable to his professional brethren.

He was a frequent contributor to the journals, and was always interested in and did much to promote association work, being a member of quite a number of dental societies and a very general attendant at their meetings, always ready to do his share to promote their interests.

His professional life presented an example that influenced many in the profession, and especially its younger members.

He became a member of this body July 18, 1864, and was its warm supporter till the time of his death.

His passing away leaves a vacant place that will not be readily filled. The profession, and especially this Association, cannot afford to lose such members as Dr. Morrison.

Resolved, That the record of this report be placed on a memorial page of the proceedings of this Association, and that a copy be sent to the dental journals and to the families of each of the deceased.

J. TAFT,
C. N. PEIRCE.

ANNUAL ADDRESS.

By JAMES TRUMAN, D.D.S., President.

MEMBERS of the American Dental Association:

The annual gathering of a body such as this constitutes an ever-recurring era in dentistry, and should mean, to the reflective mind, a period of advance along all lines of work. If this fails to be realized, then the year has been valueless, and should be regarded as a period lost in the progress of the race.

The interest that has been manifested everywhere since the close of the last session of the American Dental Association, at Saratoga, indicates that the dental profession is fully alive to the importance of this meeting at Old Point Comfort, and of the possibilities which may accrue from its deliberations. I therefore wish to congratulate you on the fact that those here assembled have met upon a mission not second in importance to any of the meetings that have preceded this, and it may, perhaps, when the results have all been summed up, transcend all others; for, if the feeling be judged aright, we have reached the "parting of the ways," and the rising sun of another day already appears above the horizon, illuminating the approaching century with a golden halo, indicating brilliant but as yet unfathomable possibilities.

The work of the past year will compare favorably with that of those preceding it. Yet it must be conceded that the spirit of activity is not abroad in the land, or in our profession. It is unfortunately too true that our calling tends to physical depression and disinclination to that higher work so necessary for advancement. The physical slavery which practice entails is not conducive to active mental effort, and the exhaustive day inclines to rest rather than to renewed activity during the evening hours. The result of this enforced inertia is to self-sacrifice, and the man of

investigating mind will turn indifferently from the bank account to the solving of problems, and eventually he becomes, not a practitioner, but a laboratory devotee. Through this division of labor there has arisen a very small class who are the prophets of the age, and these are they to whom we have learned to look for the new ideas which mark progress.

The various reports will call to your attention the things new and old of special interest. It will suffice here to say that the practical side of dentistry has not exhibited any features during the year worthy of special comment. This, however, must be said, that the literature of this portion of our work has been greatly enriched by several notable productions, and while there has been little absolutely new, there has been marked improvement upon older methods of work.

The uncertainties attending the introduction of cataphoresis have received careful practical observation and quite thorough experimental tests, and this process is gradually finding its true level in practice. Its adoption by the dental profession has been certainly phenomenal, and this constitutes its greatest danger, for the unwise rush in and attempt the impossible, forgetting that pain is the sentinel upon the advanced picket-line and an ever-present warning of danger. To use this method to the best good of the patient means a high order of anatomical knowledge, so far as the teeth are concerned, and this point needs more and more to be impressed upon the dental mind everywhere.

The work in what may be called the scientific side of dentistry has received fresh impulse through the labors of Black, Andrews, and Williams, and the labors of dentists in England and on the continent have advanced our knowledge and aided in the solution of many abstruse problems. That a large portion of this work has been accomplished by Americans is worthy of special mention at this time. It is recognized, however, that science knows no nationality, and any attempt to erect boundary lines should be crushed in its inception; but, while this is true, the fact remains, and it is one worthy of self-congratulation, that at last, in our history, a class has arisen in this country the equal of any similar body of unselfish men to be found among the older civilizations, and worthy of the highest honor. This class must ever remain a small one, but it is to its efforts that we must look for the ennobling of our race on this continent in all the higher walks of intellectual life.

In this connection, it is befitting the occasion that we express our deep regrets and sympathy that the most brilliant exponent of this class, Professor W. D. Miller, is physically suffering from the exhaustive labors to which he has subjected himself. It is felt that all here assembled will send back to him the expressed desire that he may know a full restoration to health and activity.

The year has brought with it serious losses in our ranks, both at home and abroad. It is proper that we should stop in the busy whirl of daily duties and consider what these men were to us and what we owe to their memories. Their mission on earth has been completed, but the work they did is the precious heritage of their profession, and it should be our duty to treasure it and add thereto, that the incoming century may feel the diviner inspiration to more exalted ideals.

The Committee on Necrology will doubtless present suitable resolutions upon the character and work of our revered members who have passed from the shadow of things to the eternal verities of the life everlasting.

To review a year is not difficult, but to grasp the progress made in a century is a problem from which the wisest and most cultivated might well shrink in dismay. The attempt will not be made here, but the near approach to the close of the nineteenth era of Christian brotherhood naturally causes a retrospection, and the query is ever uppermost, "What have we stored up for our profession in the past one hundred years?" It is a very glib expression upon the tongue of the unthinking that all we know of dentistry worthy of the name has been acquired in this century. While this period has been fruitful in progress, the claim can never be made that we owe little or nothing to the one hundred years preceding. The intelligent student of dental history soon comes to recognize that we must moderate our claims and give credit to the last century as being worthy of our highest regard. It must be learned further that this child of the professions—dentistry—was not born in America, but was nurtured in France, England, and Germany, and developed there upon a broad experience, that made its fractional life here in America but a continuation of that of the years preceding.

While this is gratefully conceded, it must be acknowledged that dentistry has shown an increased vitality upon this continent, and

that the progress made has been proportionately greater here than elsewhere. Neither in the Old World nor the New was there any real advance in this work until near the close of the last century, when porcelain teeth were introduced by Chemant, of France. Then, in the present century, came the introduction of arsenic for the devitalization of the pulp by Spooner, of Montreal; the filling of the canals; the revolution in surgery by the discovery of anesthesia by Wells and the introduction of ether by Morton, both dentists; the introduction of cohesive gold by Arthur; the adoption of the mallet, and the invention of the electrical mallet by Bonwill; the invention of the various forms of dental engines; the rubber-dam, and, finally, the use of electricity as a motive power and as an obtundent. These are the prominent and marked stages which have been taken, each aiding to carry us forward to our present position. The countless details of minor improvements cannot even be mentioned here, but without their aid all present know that the practice of dentistry would, to many, be almost impossible.

The crowning glory of the century, next to that of the discovery of anesthesia, has been the solution of the problem of the ages, caries of the teeth. While giving due prominence to the labors of a host of active investigators, from the days of Leeuwenhoek down through Erdl, Ficinus, Klencke, Leber and Rottenstein, Milles and Underwood, Magitot, Tomes, we must give the credit for the final completion of the great work to Professor W. D. Miller, resident of Berlin, Germany, but native of this country. It is a special cause for congratulation that this investigation has been completed in this era and during the two decades that close the century.

It is also worthy of historical mention that dental education received its first impulse in Baltimore, Maryland, the adjoining State to that in which we are now assembled, Virginia, the Mother of Presidents. The wave thus started has been widening its circles ever since, until it has embraced all civilizations. The progress in this direction is unexampled in professional educational work, and it is safe to assume that it has not only reached an equality with that of general medicine, but, in some respects, has led that venerable mother into paths she had not thought of treading. The steady advance in the standard of dental education, the extension of the curriculum, the erection of noble buildings for dental train-

ing, the grasp of new ideas, are all signs of that activity which makes for progress. It was a natural sequence to this when Professor Winder, dean of the original school of dentistry, suggested the formation of a legislative body for all dental colleges, and the outgrowth of this idea was the formation of the National Association of Dental Faculties, not the least of the remarkable products of the century. To this organization we owe all the advances made in dental education in the United States, and we, as a profession, may look forward with trustful confidence that its work in the future will maintain the high record it has earned in the past.

The natural and final result of advanced thinking and acting is law. A world without law would represent chaos, if such a condition be thinkable. Law, in the professional sense, is the embodiment of orderly rules of conduct, and should be recognized as necessary for the good government of dentistry, as well as all organized bodies. The result of educational advance meant a proportionate demand for restriction,—law-making. There is the natural law of all things which works for harmony, and there is the man-made law, which is very frequently a source of inharmony. The final outcome of this legal tendency has been laws in every State, a National Association of Dental Examiners, and a general feeling of disquiet among all teachers of dentistry as a consequence. Whether this product of the nineteenth century is to result in the good anticipated by those who worked for it remains yet to be seen, but it is hoped that this Association will see the way clear to formulate something that will tend to quiet the growing antagonism engendered by the unwise multiplication of statutes. The subject is a large one, and has frequently claimed the attention of my predecessors in office. As these laws at present stand, they are a dangerous obstacle in the path of professional progress, and promise to be the one blot upon the otherwise fair fame of the century in dental work. This applies not specially to individuals, for it is recognized that it is mainly the outgrowth of a mistaken sentiment that force, through law, will accomplish everything. The aim should be for a unity of effort with the least friction, State with State, accompanied by a positive recognition that the decree of one State should, in this matter, be a law for every citizen of the United States. The Constitution of the United States expressly declares,—

"Art. IV, Sec. 1. Full faith and credit shall be given in each State to the public acts, records, and judicial proceedings of every other State, and the Congress may, by general laws, prescribe the manner in which such acts, records, and proceedings shall be proved and the effect thereof.

"Sec. II. The citizens of each State shall be entitled to all privileges and immunities of citizens in the several States."

These quotations are apparently clear, and they unmistakably point to two facts: that full faith and credit shall be given in each State to all the acts of every other State, and that Congress shall prescribe the effect of all such laws and how such shall be proved; and further, that a citizen of one State shall be entitled to all the privileges of citizens of the several States. It is therefore clear that a law passed depriving a citizen, who has been declared legally entitled to practice in any State, of the privileges of registration in another State is unconstitutional, and it is difficult to understand how the Supreme Court of the United States could decide otherwise if a case should be carried before it for adjudication.

Out of forty-three States and Territories having laws regulating the practice of dentistry, in thirty-two the Examining Boards are appointed by the Governors. In eight the State Societies have the selection; in one the Board of Public Works selects. In another the selection of the board is partially made by the Governor. In another the appointments are made by the Board of Health, and in the District of Columbia by the Commissioners of the District.

The graduates of the dental colleges of this country are subjected to the final decision of men who are not accountable to the dental profession, but owe their places to political preference. The boards may be, and doubtless are in many cases, composed of men worthy to fill such responsible positions, but how is it possible to determine this fact? It is not surprising, in view of the origin of the large majority of these boards, that the National Association of Dental Examiners should attempt to declare what should or should not be the curriculum of each of the dental colleges of the United States. The only apology that can be offered for this insidious blow at dental education is that it emanated from men who have no familiarity with dental teaching, and who have based their conclusions on impracticable theories.

It is not possible, perhaps, for the American Dental Association to legislate to correct this growing evil of State boards, as such action would be inoperative. It can, however, use its powerful in-

fluence, as the representative body of American dentists, to have all places on the boards filled upon the recommendation of State dental societies, or by bodies having similar powers. The suggestion made that persons to be eligible for State examiners should themselves be examined is certainly worthy of consideration; but at present there is no power to compel this, and it will be a long time in the future before a general law by Congress will be passed covering professional education in the States.

The deep responsibility of this occasion must be felt by every one here assembled. It means the old interrogatory,—old as humanity,—"What shall we do to effect our salvation as a national organization?" The hour has come for action, but the hour brings with it thoughts new and old. The past historical record of the American Dental Association is replete with undying memories, and the work accomplished should stir the mind to solemn reflections. In the background stand our dead brothers, and we can most truly believe that they point with uplifted arms to the future, and from the unseen comes the command, "March on!" For the progress of professions as well as civilization can only be accomplished through changes,—the death of the old, the installation of the new.

The organization of societies in dentistry in the United States is but little over half a century old. The condition of things in the dental profession in the "thirties" can scarcely be conceived by the liberal minds of the present. It was a period of isolation. The hand of every man was against his fellow-practitioner. The walls of prejudice were erected everywhere. Doors were bolted and barred against intrusion. Lips were sealed, lest they might disclose an important method of practice. Nowhere throughout this progressive land, in dentistry, was there any light upon the medieval darkness. It, however, proved to be the period before the dawn. From behind all the cloud and shadow there was heard a voice proclaiming in no uncertain tones the old cry, "To your tents, O Israel!" but it fell upon deaf ears. It was the voice of Horace H. Hayden. With true prophetic inspiration he ceased not to demand that the dentists of the time should come forth from their isolation, and with something of the spirit of the old crusaders unite and arm for the approaching conflict. The day came when Horace H. Hayden conquered, and in New York the first society was born

into life, but died in the birth. Again we find this courageous pioneer at the head of the American Society of Dental Surgeons, and then, for the first time on this continent, began the true life of associative dental effort. We rear monuments to our great men and women, but the only monument yet reared to Horace H. Hayden lies in the historical record of his deeds. Upon his neglected tomb I would lay this chaplet, that the dental profession may never forget what it owes to this one man who labored that we to-day may live.

The past of the American Dental Association is familiar to all. It is a worthy record. It began its life amidst much confusion as to organization. It was the conservative embodiment of that intermediate thought between the crushing power sought to be enforced by the old American Society of Dental Surgeons and that extreme liberal sentiment embodied in the American Dental Convention. The organizers of the American Dental Association builded well for their day and generation, with the result that it has continued its active life for thirty-eight years. Has it fulfilled its destiny? Time alone can answer this profound question. We are here to-day to meet with our Southern brethren to attempt the solution of a difficult problem. The affectionate interest of long association lingers around their organization as well as our own. Is the ultimate result to be that we meet to-day on consecrated ground to bury our past loves, to scatter the elements of separation to the four winds of heaven, and over the ashes erect the new temple of which the fathers had no conception, a union of all professional thought upon a foundation that will sustain the superstructure for many years,—it is hoped, far into the coming century?

The conditions under which the American Dental Association was organized made it impossible to effect radical changes in old methods. The period was replete with crudities in practice and theory. Colleges were few and not well arranged for the training of students. Ignorance prevailed of those scientific studies which were rightly regarded as essential to a true knowledge of the human organism. It was therefore impossible to form a strictly scientific body. Is this the condition at present?

Year by year the standard of training has been increased in our colleges, through the wise action of the National Association of Dental Faculties, bringing us to a period of enlarged culture,

enabling us to view calmly and consider well our relations to the present and to the future.

The organization of a body such as has been contemplated is a serious matter, and should not be hastily entered upon. It would not be proper in this address to do more than suggest a path that would seem to be the correct one to follow.

We live in the present, but must build for the future, or that future will take the matter out of our hands and destroy the work of this day and generation. It is feared that the importance of this is not fully appreciated. The basis of all dental national organizations is derived from the American Medical Association. This, as stated, served its purpose well for that body, but in the American Dental Association this has tended to weakness, so much so that the cry has gone over the land, "The American Dental Association has ceased to be a body worthy of our support!" While this at no time has been true, the fact that such a statement has been heralded everywhere is indicative of a feeling that old methods have subserved their purpose and a new order of things is demanded. In view of this it would seem as though reorganization must, to be effective, be based upon an entire change of methods. Without attempting a solution of this matter, it may serve a purpose to point out what may be regarded as some things worthy of change in the old Association. The first step in a national professional organization should be the proper arrangement of local societies. From these the national body must be formed. These local societies must be in direct connection with the national, and, therefore, be established upon a careful ethical basis, and a positive standard of entrance. This, as a rule, is entirely neglected, resulting in a membership of uncertain quality. The representation to the national body is selected with more regard to availability than to qualifications. These delegates, if so disposed, become permanent members of the national organization, and eventually become part of the controlling body. In proportion as this grows will it become unmanageable and lose its scientific character. This is the history of all similar bodies so constituted. Science does not, cannot flourish in crowds.

The question then would seem to be, "Can reorganization be accomplished upon a different conception?" It will be difficult to change present methods in local bodies, but proper legislation in

the national organization could in time effect much. A glance at the present and past condition of the American Dental Association may prove of value. The ineffectual efforts to increase the scientific work led to the formation of Sections, under the supposition that these would tend to concentrate the labor and accomplish more than when left to the efforts of committees. The result has been no improvement over older systems. This is not stated as a complaint, for it is recognized not to be the fault of individuals, but of methods. The system is intrinsically weak, and can never effect any permanent good results.

The first fatal injury done to any organization is to found within its borders an aristocracy. This has been accomplished in this and similar organizations by the establishment of what is known as permanent membership. This has been the deadly poison that has eaten out the life of this American Dental Association. It was an aristocracy not based, as it should have been, as a prize for higher work, but upon ability to pay the yearly fee and attend the annual meetings. This separated most of the desirable element in the profession, and as a consequence very little of the real scientific work has been done within its borders.

If these views be accepted, it would seem worthy of our careful thought whether it is not time to originate a body distinct from all others, and which should embody elements of strength rather than weakness.

The idea which this address seeks to impress is that a national body should be the culmination of all below it. It should embrace the concentrated wisdom of all subordinate societies. In order to make it thus, the affiliating organizations should send to the national only such members as had given the profession satisfactory work. Their entrance and continuation in the national association could be arranged so that the latter would always be an active, living organization. The only aristocracy admissible should be a class set apart, who had earned special honor. This would never be a large number, and might be selected from the main body, with an honorary title.

With this care in the selection of members, the national body would always remain within working limits, and would partake of the character of the higher scientific bodies of older civilizations.

The suggestions here outlined will not in all probability meet the views of the majority, but it is hoped that if a new body be formed out of the two present organizations it will embody at least some improvements over those long in existence. They have been tried and found wanting in those essentials that work for the highest good of the dental profession. It will not be disputed, it is presumed, that a national body is a necessary part of the organization of a profession. This recognized, it should be the aim of those having the matter in charge to make it worthy of the respect not only of the present time, but of the future.

The recent meeting of the American Medical Association, in Philadelphia, demonstrated that the division into Sections to meet separately from the main body is not a satisfactory method. It is questionable whether much good is derived, even in medicine, from this practice, where specialties are more clearly pronounced and certainly more desirable; but in dentistry there is no such demand. We are, or should be, interested in every portion of our work, and can therefore meet on common ground, enlarging our horizon of thought and experience, and at the same time cultivate those social amenities so important in maintaining good fellowship among widely separated members of the same professional family.

The experience of the past few years has demonstrated that it cannot be expected that the regular practitioner of dentistry will, outside of a few isolated instances, work for the advance of his profession if it interferes with his daily work. The altruistic side of dentistry needs cultivation, but it will never assume large proportions. The true investigator of problems invariably finds practice irksome, and he is always ready to burst the bonds which environ him, if necessary, for the more enjoyable fields of the mysterious unknown. Few there are who can do this with that other problem, —daily bread,—staring them constantly in the face. It would seem therefore that the time had arrived when some means should be arranged to set free these imprisoned students and make it possible for them to work independently of the cares of life. When the new organization is perfected it is hoped that the possibilities in this direction may be considered, and that a fund may be established looking to financial aid to those who are continually sacrificing themselves and those depending on them that the profession may progress worthy of its high aspirations. Science seeks the

cloisters in the world's life. Is it not time that we make those cloisters free from worldly anxieties?

With our faces averted from the past and present and directed to the opening of the new day, we can consistently ask, "What of that great future which lies before us?" Who has the prescient wisdom to fathom its possibilities? It is the as yet uncultivated plain; its mines have not been laid bare with pick and shovel; its gold and precious stones still remain environed by the accumulated mire and rocks of undetermined time, but over all these floats the spirit of progress, and her wings are never idle, nor will she be found wanting in inspirational power to influence men to work out the problems of the coming ages. The promises of that future will assuredly meet with full fruition, and we can confidently anticipate that, inasmuch as we have builded well with imperfect tools, those who come after us will rear more substantial structures and carry the profession of dentistry to a standard as yet unthought of in our wildest imaginings.

Men of the North, South, East, and West, here assembled on ground consecrated by the martyrdom of many heroic spirits, can you not come together actuated by that same high sense of duty that led the thousands to sacrifice all of life's treasures for the good of others, and pledge yourselves to a renewal of effort to complete brotherly relations, forgetting the old and grasping the new, move onward in fraternal harmony toward the anticipations, the possibilities that lie entombed in the ever-developing future, the heritage of the incoming civilizations, which should prove the blessing of humanity, the ennobling of the professions, and the upbuilding of the life and intelligence of all the peoples of the earth?

REPORT OF SPECIAL COMMITTEE ON PRESIDENT'S ADDRESS.

To the Members of the American Dental Association:

Your Committee confidently expect that the proposed union of the American and Southern Dental Associations will shortly be consummated, and their recommendations, therefore, are made to the Association about to be created by such union.

We recommend that all delegates to the Association shall be practitioners of dentistry who shall be selected by State Dental Associations at a regular meeting of the association which they represent; that they shall be men of recognized merit, and duly selected by a majority vote of such State organizations.

We recommend that one delegate shall be allowed for every ten members of such State organization.

Your Committee believes that with such careful election of delegates the formation of an aristocracy so forcibly described in your President's Address would be prevented.

Your Committee recognize the timely recommendation that some method shall be adopted by which a fund shall be created by the national association, which shall be devoted to original investigation; such fund to be used in enabling competent scientists in the profession to prosecute investigations without being harassed by the usual strife and annoyance encountered in dental practice.

Your Committee is in perfect harmony with the President when he says that the decree of any State should be a law for all other States, and that a practitioner who is properly licensed in one State should be allowed registration in any, and that this Association should advise all of its members to work for the accomplishment of this desirable end.

In regard to dental education and to the conflict which has arisen between the National Association of Dental Faculties and

the National Association of Dental Examiners in respect to educational methods in the profession, to which extended reference is made in your President's Address, your Committee is of the opinion that there is no reason which should prevent harmonious relations between these two bodies. The aims of the National Association of Dental Examiners have been in the proper direction. They have been invested with authority by the various States to guard the community interests where they exist; and while individual members of boards have expressed unwise individual opinions, the public and majority action of the Examiners Association has so far not exceeded their lawful and legitimate functions. They are entitled to our respect, and invite harmony in dental education. Your Committee, while concurring in the majority action of the Examiners Association, desires to pointedly criticise the method in some States of granting temporary licenses to practice, and would earnestly advise that efforts be made to change the laws permitting such licenses without any examination whatever. In furthering the intent of the President's Address, your Committee desires to deplore the lack of interest in the national association evidenced by a considerable portion of both the membership of the National Association of Dental Faculties and the National Association of Dental Examiners, in that they have not and evidently do not desire to work with the National Association. So soon as the business of these two associations is finished, many of the members at once return to their homes. This is done in face of the fact that, of all associations, the National Board of Dental Examiners and the National Association of Dental Faculties should be the most loyal to national organizations, and thus further the community interests of dental education.

In conclusion, your Committee believe that nothing will be gained by exalting the work of one or belittling the work of the other.

J. D. PATTERSON,
H. B. NOBLE,
L. L. DUNBAR,
H. J. BURKHART,
GRANT MOLYNEAUX.

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SECTION V.

MATERIA MEDICA AND THERAPEUTICS.

The Phenomena of Cataphoresis.

PAPER BY WESTON A. PRICE, D.D.S., OF THE SECTION.

IN this paper we will confine ourselves to the consideration of the phenomena attending the application of an electric current to the human body, *with* and *without* an interposing medicament, and especially its application to the dental organs.

There are three distinct theories as to the forces at work and their particular action in these processes, and, since there is such a diversity of nomenclature and variety of method for the application of these forces, we will include in this consideration all the methods of applying an electric current to the dental organs for producing anesthesia, whether used in conjunction with a medicament or not.

These theories are,—

First. The polarization of the tissue, producing an inhibition of the sensory impulse.

Second. Osmosis.

Third. Electrolysis.

The first theory provides that when an electric current is applied to a tooth, with or without a medicament, the conditions produced are due entirely, or almost entirely, to the effects of the current and not due to the medicament, other than its assistance in conducting a current. The supporters of this theory are here divided into two classes, from a difference of opinion of the exact

method of this inhibition,—whether the decreased excitability is due to the polarizing effect of the current on the tissue, or to its inhibition of the normal sensory impulse by its passage through the nerves.

So far as I know, the leading advocate of the former theory is Professor Neiswanger, of the Post-Graduate Medical School of Chicago. I have also heard Drs. Husted, Oberlin, and Heise, of Cincinnati, and some others favor this theory.

Professor Neiswanger said, in the discussion of an allied subject at the Ohio State Society meeting last December, that owing to the liberation of hydrogen at the negative pole and of oxygen at the positive pole there would be at these two regions respectively a condition of increased and decreased excitability, due to the production of an acid condition at the positive pole and of an alkaline condition at the negative pole, and that the zone of neutrality would be the median of resistance, and consequently that the negative or indifferent electrode should be placed as far as possible from the polarizing electrode. He detailed minutely the action of the gases on the tissue.

The adherents of this polarization theory maintain that the amount of current used is not great enough to cause sufficient electrolysis of the medicament used to produce its effect on the tissue. We will not stop to discuss the various theories until we have stated them all.

The other division of this first theory is, that a constant current applied to the dental branches of the trifacial nerve, with the positive pole applied to the tooth and the negative pole over the Gasserian ganglion, inhibits the normal sensory impulse. The leading advocates of this theory maintain that a certain and intricately definite amount of current, applied in the manner just described, will produce a condition of anesthesia in the tooth, and that either too little or too much will not produce this condition. They call it "short-circuiting the nerve." For its application the positive pole of the constant current is attached to the dental engine in such a manner as to make the bur the electrode, the handpiece being insulated and the negative pole applied over the Gasserian ganglion, on the same side as the tooth to be operated upon, which is perfectly insulated. The chief supporters of this theory are Drs. Horton, of Cleveland, and Lyder, of Akron, Ohio, with a

host of sympathizers. No medicament is used in either of these two processes except moisture in the former, the polarization theory, to reduce the resistance of the dentin. In the latter, the Horton method, the cavity is dehydrated.

The next theory provides that the medicament, which is applied under the electrode, is the agent which does the work, but that it is carried in by a physical force; that in some way, just as a stream of water carries sediment with it, so the electric current carries the ingredients in solution with it through the solvent and through the tissue. The advocates of this theory have furnished almost all the literature that has been written on the theory of cataphoresis since its advent, and in its ranks are to be found many of the foremost men in the dental and medical professions. The most exhaustive articles bearing out this theory have been written by Drs. Morton, Peterson, and Phillips, while a number of shorter articles have appeared from other writers.

To secure the conditions best suited for the development of this process, the positive pole is placed in the cavity or on the tissue to be anesthetized, with an interposing layer of the obtunding medicine, and the negative pole placed at any more or less remote place.

Dr. Morton has said (see Proceedings of the First District Dental Society, New York, December, 1895), "You may even drive solid particles into tissue, and solid particles will move through fluids by the aid of electricity." He says in the same article, "You cannot be too sure of your osmosis."

Dr. Peterson, in his introduction to his valuable article in "The International System of Electro-Therapeutics," says, "From a medical standpoint, we understand by cataphoresis the introduction of medicaments, by means of electricity, into the body through the skin or mucous membranes. It seems to be a *purely physical process*, and has nothing to do with electrolysis." Very many others could be quoted from as supporting this theory with which doubtless you are familiar, but we will pass to the statement of the last theory, namely, electrolysis.

This theory provides that practically all the effect produced in passing an electric current through a medicament as applied in cataphoresis or in any other way is electrolytic. I have not been able to find a single person except one among the writers for

the medical and dental profession defending this theory. It may, however, be worthy of consideration.

As the next steps let us consider,—

First. The physiological effect of a constant current on nerve-tissue.

Second. The laws governing osmosis.

Third. The laws governing electrolysis.

For the study of the first, take, for convenience, the sciatic nerve of a frog. Apply the electrodes of a polarizing current to two distant points from each other on the nerve. Before considering the phenomena of muscular contraction let us observe the conditions this current produces in the nerve, relative to any other irritant applied to that nerve. Suppose the irritant to be mechanical, not electrical, to prevent confusion with the polarizing current. The negative pole of the polarizing current is placed nearest to the muscle. The following phenomena will be observed:

First. That the nerve at different points has altered excitability. At some places less than the normal amount of stimulation will produce a contraction of the muscle, while at other points it will take far more than the normal amount of stimulation to produce this contraction, due to the passage of a current.

Second. It will be found that these regions of increased and decreased excitability are confined to the vicinity of the particular electrode,—the region of decreased excitability about the anode, or positive electrode, and the increased excitability about the cathode, or negative electrode.

Third. There is a point between the electrodes of normal excitability, which point *varies* in distance from the respective electrodes according as the current is *weak* or *strong*.

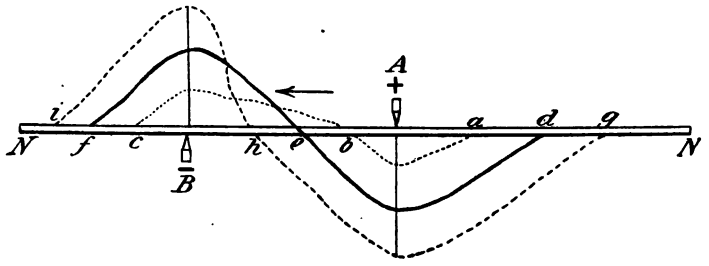
Fourth. The *degree* of *decrease* or *increase* of excitability is in *direct proportion* to the strength of the polarizing current.

Fifth. This condition ceases practically at the instant the current is broken.

The alteration of excitability in the region of the poles we will know as electrotonus; that at the positive pole, or anode, as anelectrotonus, and that at the negative pole, or cathode, as catelectrotonus. These terms have been used by different physiologists to express two different conditions.

In 1843 Du Bois-Reymond discovered that the passage of a

constant galvanic current through a portion of a nerve produced a change in the electro-motive forces existing between the longitudinal and transverse surfaces, whereby the resulting *nerve-current* was either increased or diminished, according to the direction of the constant current. To this condition he applied the term electrotonus. It was subsequently shown by Pflüger, in 1859, that a definite change in the irritability of the nerve is also caused by the passage of a constant galvanic current, and as it is intimately related to the change in the electro-motive forces he applied to this *alteration of excitability also the term of electrotonus.* This will be the application of the term in this paper. He showed very clearly by the diagram the relative effects of different currents. "The abscissa line *N N* represents the nerve, the decrease in the excitability of which is indicated by an ordinate directed downward, and the increase in excitability by an ordinate directed upward. The electrodes conveying the current to the



nerve are represented by *A*, the positive, and *B*, the negative pole. The relative extent of the alterations of the excitability, as revealed by the energy of the muscle contraction following the application of a uniform stimulus, is shown by the curves, the size and extent of which represent the changes produced by a weak, medium, and strong current. The curve also shows that with a weak current *(a, b, c)* the excitability in the anodal (positive) zone is decreased and in the cathodal (negative) zone increased, and that the neutral point *b* lies close to the side of the positive pole. From this point the changes in excitability gradually increase, and reach their maximum in the neighborhood of the electrodes, from which both phases gradually decline. The position of the neutral point also indicates that by far the larger portion of the intra-polar

region is in a condition of increased excitability, or catelectrotonus. The curve *d, e, f*, similar in its general form to the preceding, represents the alterations in the excitability produced by a current of medium strength; in direct proportion with the increase of current strength, there is an increase in the amount of anelectrotonus and catelectrotonus and the distance to which they spread themselves into the extra-polar regions. The indifferent point has advanced toward the center of the intra-polar region, indicating that this portion of the nerve is almost equally occupied by the opposite states of excitability. The curve *g, h, i* represents still further the changes following the employment of a strong current. The neutral point has now been shifted toward the cathode, and the intra-polar region is in a condition of anelectrotonus." These changes in excitability are not dependent upon or related to the special nature of the electrical stimulus, for they exhibit themselves upon the application of all forms of stimuli, whether mechanical, chemical, or thermal. The degree of electrotonus is in direct proportion to the strength of the constant current, even to the point of the destruction of the continuity of the nerves. This is a very important fact.

The foregoing laws pertain to motor nerves. Nothing analogous has yet been observed in secretory nerves, but Donders confirmed it in his experiments upon the inhibitory fibers of the vagus. *Does an analogous condition exist in sensory nerves?* This will be observed later.

These preceding laws, as also the laws of contraction produced by an electrical stimulus, have been established on the isolated nerves of frogs under abnormal conditions. Can they be verified on the living human body? Yes and no. Not, of course, under the same conditions, though they can under very complicated conditions. Why can they not? Because of the nerves being surrounded by tissues of different degrees of resistance. This will be the key to the answer of one of these theories.

Suppose the positive pole be placed in a tooth and the negative over the Gasserian ganglion, and suppose, for argument's sake, that the sensory impulse is inhibited, just as the motor is. Will the current travel on the nerve or on the surrounding tissue? To determine this I chloroformed a dog, and with expert assistance dissected out the inferior dental nerve from near the base of the

skull to the inferior dental foramen and insulated. The lower cuspid on the same side was excised and insulated, and an electrode placed in the pulp-tissue. With very great care the current through the path, the "pulp and nerve," was determined and found to be 23,630 ohms. The resistance through the path, "the pulp to a point equidistant away on the muscle," with the same electrodes, was determined and found to be 18,570 ohms, which was 5060 ohms less than that of the nerve.

What does this mean? Simply that if the Gasserian ganglion were right on the surface and the negative pole applied to it, the amount of current passing through each, the nerve and muscle, would be inversely in proportion to their resistance. But the nerve does not come to the surface, hence the current to pass through the nerve must travel along on it to a point opposite the negative electrode and then pass out through the tissue to the surface, which the advocates of this theory claim it does. But an electric current always seeks out the path of least resistance, so to fulfill the requirements of this theory the resistance through the nerve would have to be infinitely lower than the resistance of the surrounding tissue. A point of interest here is that the cross-section resistance of a nerve is still five times greater than its longitudinal resistance. The facts are that the current would diffuse throughout the entire tissue of that side of the face, and the amount of current flowing through the nerve at any point in cross-section would be less than that flowing through the same cross-sectional area of the tissue at any point around it within a wide area. Hence the theory of *short-circuiting a nerve* is inconsistent, and its accomplishment in dental therapeutics clearly impossible.

I have demonstrated this same fact on the inferior maxillary of a sheep and on the sciatic nerve of a frog. This is a very important consideration, since it determines to a greater or less extent the possibility of the realization of the fundamentals of both the inhibition and the polarization theories. It was because of this fact that Erb, in 1867, failed to verify on the human body the laws established by Pflüger in 1859. (See *Deutsches Archive für klin. Med.*, Band III, S. 238, 513.) He found as a constant result of many experiments that there occurred a diminution of excitability in the extra-polar catelectrotonic region and an increase in the extra-polar anelectrotonic region.

Helmholtz subsequently demonstrated that the cause of this deviation from Pflüger's law is the position of the nerve in the uninjured body. He says, "Since the nerve is in a position surrounded by a well-conducting medium, even better than itself, the current density in the nerve must rapidly decrease with distance from the electrode. While, of course, under the polarizing electrode the current density in the nerve is the greatest, this density, on account of the moist conductors surrounding the nerve, so rapidly decreases that it becomes almost *nil* for the nerve at even a small distance from the electrodes. At a small distance from the positive pole, therefore, the density is so slight that it may be assumed without error that the current now leaves the nerve, or, in other words, that the cathode, so far as the nerve is concerned, is to be found at this point. It is to be expected, therefore, that the effects of the opposite pole would be observed at only a short distance from the applied pole."

Erb, at this suggestion, renewed his investigations, eliminating this error, and got results harmonizing perfectly with the laws established by Pflüger. For his method of eliminating this error, see Bigelow's "International System of Electro-Therapeutics."

This fact was more thoroughly established by Waller and De Waterville (Physiological Transactions of the Royal Society, 1832), to which reference can be made, or to Waller's "Human Physiology," 1891, page 363.

Now to return to the application of a constant current to the dental organs. Where will the current leave the dental nerve if the positive pole be upon the exposed pulp and the negative elsewhere? I need not go into the anatomical structure of the pulp; with that you are certainly all familiar. Nearly two-thirds of a pulp-chamber consists of blood-vessels and their contents; much less than one-third of nerve-fiber, and the remainder of connective tissue, etc.

The blood has a greater conductivity than the nerve-tissue for the same cross-sectional area, consequently most of the current will travel through the surrounding tissue and not through the nerve-tissue. The size of the apical foramen and the resistance through the walls of the pulp-chamber are of some importance in this connection, but time will not permit of their discussion here. In the case considered above but a very small per cent. of the

entire current flowing would travel for any distance on the nerve-fibers, since it would go direct to the less resistant tissue. Suppose the current applied just as in the last case, except that the pulp is not exposed and the current must pass through the dentinal tubes. Here, it seems to me, would be an ideal condition for the demonstration of either the polarization or the purely inhibition theory. We would expect that since these tubes contain chiefly the projected fibers of the odontoblastic or spindle-shaped nucleated cells surrounding the pulp, and which are supposed to be the periphery endings of the dental nerves, the current would of necessity have to pass through this structure to the pulp before it could disseminate to the other structures. Of course, the lime-salts of the dentin are a non-conductor. If any effect is produced by applying the current in this manner through the drill, it must be on this structure in the tubes, for it would disseminate immediately on arriving at the pulp-tissue. We shall not discuss whether or not these cell projections fill completely the space of these tubuli; probably so, or very nearly so. However, the fact we wish to establish can be easily clinically demonstrated.

Will the current applied under these conditions produce anesthesia of the part to any considerable extent, and why? This is to be answered clinically and theoretically. I give my answer guardedly and after giving the question a very thorough investigation to my own perfect satisfaction, *No.* From a physiological standpoint it would not be possible, since we are dealing with a sensory nerve, whose function is to produce the sense of pain with the very slightest irritation, and with the most sensitive one in the whole human structure.

If the sensory nerve did not respond in the form of pain to the passage of the current we should expect even then that the amount of current necessary to produce this condition, judging from motor nerves, would be many milliamperes.

But you say that the impulse which carries the sensation of pain in the sensory nerve is related to the internal nerve-current of the nerve discovered by Du Bois-Reymond, and why could not this impulse be interposed by an artificial current, thus preventing the pain impulse to pass? This can be answered in two ways: First, this *nerve-current* always travels from center to periphery in motor nerves and from periphery to center in sensory nerves,

always in the direction of the impulse: hence it would be in the same direction as the polarizing current, which really increases this *nerve-current* when in the same direction. We should then expect on this theory an increase of sensitiveness.

Again, the normal sensory impulse has no connection with this *nerve-current*, and again even the origin of this *nerve-current* would answer this question. It is to my mind the height of unreasonableness to expect to be able to pass enough current through that sensory nerve to produce the condition of anelectrotonus, since the pain limit will permit scarcely the thousandth part of so great a quantity of current to be passed as would be necessary to produce that same condition in a motor nerve, provided the sensory nerve were capable of an analogous reaction. For the clinical answer to this question I have tried in vain to produce this condition, using every variety of conditions in the tooth and combinations of potential and resistance possible in instruments on the plan of this theory. It is very simple, and would be ideal if possible. Any good cataphoric apparatus will produce every possible combination of any of these instruments that I have seen that are in use at the present time, though not as they were first used. The Horton instrument has a possible total potential of less than six volts and has a variable resistance of less than 50,000 ohms in series, and divided into twenty-four divisions in such a way as to make almost any combination up to that total possible.

I have demonstrated elsewhere and verified repeatedly that the resistance through a tooth, accordingly as the cavity is wet or dry, will vary all the way from thousands to hundreds of thousands of ohms. I have measured cavities in dentin after dehydrating, and found them to vary from 20,000 ohms to over 1,000,000 ohms, and in different parts of the same cavity almost that amount of variation over the surface of the dentin alone, while through the enamel, of course, these figures would be multiplied by thousands.

Two things must be evident to every one at a glance,—viz, that in delivering the current to a tooth, from the bur as the positive electrode, it is impossible to have a uniform amount of current flowing as the bur is moved to different parts of the cavity, owing to the variableness of the resistance of the different parts of the cavity, and that with so very high a resistance it would be impos-

sible to have more than an extremely weak current flowing unless the potential were very many times that used.

With the instruments I use, which have been specially constructed, I can measure with precision and express in amperes any amount of current, from the one-hundred-and-twenty-five millionth of an ampere to one-twentieth of an ampere. I have measured the actual amount of current flowing in amperes in the use of two of these instruments as used by their exponents, and found it to vary from six-millionths of an ampere to one twelve-millionth in one case with one instrument, and from one six-millionth to one sixty-millionth of an ampere in one case of another instrument. In my own subsequent investigations I have collated considerable data showing a much greater variation than the above. In view of the fact that this condition of anelectrotonus is in direct proportion to the amount of current flowing, I have passed as high as two milliamperes of current through a healthy live pulp and tried to work on it at the same time, but could not produce this condition of anelectrotonus, even while so strong a current was flowing. I have let it flow for fifteen minutes and not been able to produce any such condition to a sufficient degree to permit of touching the pulp, even slightly, without pain. We saw from the law established by Pflüger that this condition was in direct proportion to the amount of current flowing; hence how impossible for the millionth part of an ampere to produce this condition if two thousand times as much could not.

Another law enters at this point making the realization of the anelectrotonic condition of the dental nerve impossible, which is the law of stimulation of an electric current. This is, that it is the sudden variations of current strength which excite muscular contraction in a motor nerve or in a sensory nerve that produce its normal impulse, pain; hence when the current is delivered to the tissue from a revolving bur every blade brings with it an interruption of the current strength, which, if the current strength were great enough to produce anelectrotonus, would produce such pain as would be positively unbearable. You could scarcely imagine anything more excruciating.

I have an abundance of reserve proof for sustaining this position, among which are the personal experiences of two different afternoons' use of this process on my own teeth by the original

introducer and a couple of other similar applications of the method by other advocates, also using it myself on very many patients. Try it yourself. The only precautions are to insulate the tooth and the hand-piece perfectly, and begin with a minimum amount of a constant current and gradually increase.

What are the laws governing osmosis? This theory provides that when we apply an electric current to tissues with an interposing layer of some medicament under the positive pole, the medicament will be carried into the tissue by means of a physical force possessed by the current.

What is osmosis? It is the diffusion of a dissolved substance in a solvent to equalize the concentration.

If a layer of pure water be placed over a solution of sugar, the system immediately commences to suffer a change. The particles of sugar immediately rush from places of a higher up to places of a lower concentration. This diffusion process, as the phenomenon is called, does not cease till the concentration has become the same in all parts of the solution. Let us imagine the sugar to be separated from the pure water by a semi-permeable membrane, such as will allow of the passage of the water, but not of the sugar. Of course the sugar will exert a pressure, and since it cannot go to the water it will produce a hydrostatic force against the partition, which will be moved upward if the apparatus be so arranged that it can; or if the partition cannot move and the chamber in which the sugar is confined be arranged with a capillary tube, the water will pass into the sugar solution through the membrane, increasing the volume of the confined solution, causing it to rise in the tube to a height equal to the osmotic pressure of the sugar. The fact is, that all the conditions just assumed can be realized. This condition exists in any possible solution, and is influenced by many conditions.

The osmotic pressure of cane sugar in water has been demonstrated by Pffefer, using cupric ferro-cyanide as the semi-permeable membrane. He has shown that a saturated solution exerts a pressure of about four atmospheres, which would, at the ocean level, be about sixty pounds to the square inch. The osmotic pressure is in a definite proportion to the concentration and temperature.

This condition is perfectly analogous to that of a gas confined

within inclosing walls. It exerts a definite pressure, which is influenced both by temperature and density. The molecules of the gas tend to fill all possible space, each endeavoring to get just as far from every other molecule as possible. Just the same condition exists among the molecules of the dissolved substance; every molecule endeavors to get as far from every other molecule as possible, thus filling the greatest possible space, and they will continue so to do just as long as more pure solvent is provided.

It has been demonstrated by Nernst and Van-Hoff and others that "the osmotic pressure *is independent of the nature of the solvent*, and in general obeys the laws of gases." The various proofs for establishing this law are given in Nernst's "Theoretical Chemistry," 1895. It has also been demonstrated that "solutions having the same osmotic pressure can be obtained by dissolving equimolecular quantities of the most various substances in the same solvent."

It has long been noticed that a coincidence existed between the osmotic pressure of a substance and the gas pressure of the same substance. It is now known that "the osmotic pressure is exactly the same as the gas pressure which would be observed if the solvent were removed and the dissolved substance were left filling the same space in the gaseous state at the same temperature." There is a constant relation between the osmotic pressure, the freezing point, and the vapor tension of substances of the same molecular species.

Nernst says that "the question as to how the nature of the solvent influences the osmotic pressure of the dissolved substance is at once settled by the fact that insomuch as it is identical with the gas pressure there is no dependence at all between the osmotic pressure and the solvent." Which fact is easily demonstrated.

The laws governing the phenomena of osmosis are very clearly understood, and so perfected that the exact constancy and temperature coefficient are known for a large number of substances.

Time will not permit of anything but the most hurried *résumé* of the laws governing osmosis, but from even the few just quoted we can make some valuable deductions as to the *rôle* this force plays in the process of cataphoresis.

Since the nature of the solvent has nothing to do with the osmotic pressure, it at once becomes obvious that,—

First. It does not matter what solvent we use for our cocain, provided it is the force of osmosis that accomplishes the work.

Second. Since the osmotic pressure is in direct proportion to the concentration, the solution should be as nearly saturated as possible.

Third. Since the osmotic pressure is increased to a definite extent by each degree increase of heat, the solution should be kept as hot as possible.

These above observations hold good for practical application *if* the force we are dependent upon is osmosis. We can make our deductions both from a clinical and theoretical standpoint. Will osmosis carry cocain into dentin to any considerable extent? To answer this, I have sealed a saturated solution of cocain into cavities for two days and again for two months without producing anesthesia except on the very surface of the cavity. I have also applied it for some time on an exposed pulp, and could not cut very far into it. Sulfate of strychnia and bichlorid of mercury applied on cotton to the chest of frogs produced no physiological effect, while with a current death was produced in a few minutes. This at one stroke seems to answer the question as to whether osmosis alone can produce this condition.

Now for the theoretical suggestions. We know that if a saturated solution of cocain be placed in a cavity there will be a difference of concentration between the cavity and dentin and the cavity and pulp. We know also that the velocity of migration of the dissolved salt will depend on two things: the osmotic pressure or "head," and the resistance. We have all observed how slowly a very fine precipitate settles. This is the resistance of the solution. Just so the resistance of any solvent to any dissolved substance can be determined from the osmotic pressure and velocity.

Now, as a matter of fact, all cell-tissue and porous partitions offer great resistance to osmosis, and many cells have the power of permitting some substances to pass, while excluding others. This is the foundation of plant-life physiology, and largely of our own physiology. It is for this reason that some bacteria are so difficult of destruction.

In the dentin we have both of these conditions, and it would be expected that a very great barrier would exist here to the osmosis

of the cocain. So far as I know, no scientific study has been made of dentin in this connection. It is a good field for some one.

We are forced to conclude, from the clinical observations and theoretical probabilities, that osmotic pressure is not the force on which depends the transmission of cocain through dentin into the pulp. This brings us to a consideration of the last question,—viz,

What are the laws of electrolysis?

What is electrolysis?

"It is the change that is effected by the passage of an electric current, in so far as the electricity exhibits itself as such." How is electricity conducted? As expressed by Nernst and translated by Palmer, "The conveyance of electricity in conducting substances may happen in two different ways,—viz, *with* or *without* the associated transportation of matter. The latter happens in the case of metallic conductors (first class), the former in electrolytic conductors (second class); hence these are called conductors of the first and second classes respectively."

The nature of conduction in the first class (metallic) is unknown, but the nature of conduction in the second class, namely, electrolysis, is quite perfectly understood. From the above author I quote that "The process of the conduction of a current, as a result of electric forces, consists in the displacement of free ions." "By free ions we mean those which are not united with each other to form electrically neutral molecules; the positive ions migrate in a direction from anode to cathode, the negative ions in the opposite direction."

A solution conducts electricity the better the more numerous the ions and the smaller the friction which the ions encounter in their migration. This conception may be applied unchanged to every substance which conducts electrolytically,—whether gaseous, liquid, or solid, whether simple or mixture. Insomuch as it is impossible for a weighable quantity of a substance to consist solely of positive or negative ions,—because this would signify the accumulation of such immense quantities of electricity that the substance would at once be dissipated, in consequence of the repulsion,—therefore only *compound substances*, but no elements, have the property of electrolytic conductivity. Moreover, the molecules of the conducting substances must be dissociated in order that there may be free ions present; *and the free ions are*

divided into two classes, which are sharply contrasted, accordingly as they are positively or negatively charged.

The electrolytic charges of the ions are equally great and equivalent, whether they occur in solution or in substances having a simple composition. This would be anticipated, because the fundamental laws of Faraday hold good both for water solution and also for fused salts. It is very remarkable that *we do not know of any electrolyte which in the pure state and at ordinary temperatures has the power of electrolytic conductivity to any marked extent.* Thus, *e.g.*, neither liquid hydrochloric acid nor pure water can conduct electricity noticeably; but when they are mixed they become conductors. The reason for this certainly is not that the ions in the pure liquid experience too great a resistance to their movement, but rather that the liquid electrolytes in the pure state are dissociated only to the very slightest extent. In the passage of a current through any liquid, then, except a metal, the current can pass only by dissociating some of the molecules, called the ionization of the medium, and these ions, which are equal in quantity, migrate in their respective directions. The measure of the ions traveling in either direction is the exact measure of the ions traveling in the other direction and the measure of the current flowing.

This is expressed by Nernst as follows: "When the galvanic current passes through conductors of the second class,—viz, electrolytes, then, in addition to the liberation of heat, there occurs a transportation of matter,—migration of the ions,—and also on the limiting surfaces between the conductors of the first and second classes there occur peculiar chemical processes; these latter consist primarily in the solution of the electrodes or in the separation of the ions from the electrolytes, but they are usually complicated by secondary reactions between the electrolyte and the separated products."

This latter phenomenon, with associated reactions, has been by some thought to be a movement of solid particles.

The quantity of the ion separated in a unit of time upon the electrode is proportional to the intensity (strength) of the current, and the same quantity of electricity will in the most various electrolytes electrolyze chemically equivalent quantities of ions. In those cases where the chemical value of the ions is capable of changing, of course the meaning of *chemical equivalents* changes;

thus, the same current which separates two hundred grams of mercury from a solution of $Hg(NO_3)_2$ will separate one hundred grams of mercury from a solution of $HgCn_2$. The above author says, "It is only in the rarest cases that the ions themselves are obtained as the product of electrolysis,—*i.e.*, products which have the same composition as the ions as they are primarily separated, which differ from the ions only by having given up their electric charges. Thus the hydrogen ions appear in the form of H_2, the ions of certain metals in the form of metals, and under suitable conditions the ions of the haloids (viz, acidiferous elements) in the form of metaloids." "But much more frequently the ions either act upon each other on being separated, as, *e.g.*, in the decomposition of the acetic acid ion according to the equation,—

$$2\,CH_3\,COO = C_2\,H_6\,CO_2,$$

producing ethane and carbon dioxid; or the ions may react upon the water as when separated sodium gives off secondary hydrogen, or, finally, the ions may react *upon the metal of the electrode*, as when separated chlorin forms the respective chlorid" (or when graphite is put in a silicate of soda solution).

The (freshly separated) ions, which have been deprived of their charges by the aid of the passage of powerful electric energy, are illustrations of substances containing a large quantity of free energy,—that is, illustrations of great affinity. The (freshly separated) ions are capable of performing reactions of which they are quite incapable in the ordinary state. Thus, for example, freshly separated hydrogen, unlike ordinary hydrogen, can reduce nitric acid,—the so-called "nascent state." It is especially worthy of our notice here that electrolytic dissociation as compared with ordinary dissociation is influenced but slightly by temperature. In fact, it sometimes happens that with rising temperature it diminishes, or it may slightly increase, which is in strong contrast with ordinary dissociation, which always rapidly increases with rise of temperature.

Let us now apply some of these laws of electrolysis to the particular process with which we are interested. Suppose the positive pole to be applied to the dentin of a tooth and the negative to the cheek. An interposing layer of medicament, say cocain in water solution, is between the metallic positive electrode and the dentin. Now the only way electricity can get from the metallic

positive electrode to the metallic negative electrode is by the dissociation of some of the molecules in every substance of the second class through which it passes. In every part of the course, through the cocain solution, the dentin, the pulp, the connective tissue, the blood-vessels, the muscle-tissue, and the sponge on the negative electrode, there will be a cleavage of some of the molecules of the various chemical compositions into a positive and a negative ion. These ions, with equal force and chemical equivalents, start on their respective journeys toward their opposite poles. They meet with friction which varies for different ions, and since they have the same force behind them, pushing them, their velocities will vary with their resistance. If in their course they meet a new ion or an element or compound for which they have a greater affinity than the force which separated them, they will unite with it until they are again called into service. Unless an ion found such an affinity it would keep on going until it got to the metal plate of the negative electrode, and, if it could unite with it, would do so; if not, would be deposited upon it or be liberated in the form of gas.

Now, the question we have heard raised so often, Is the current we use strong enough to produce any electrolysis? must be settled, for if we have no electrolysis we cannot have any current flowing, and the measure of the current is the measure of electrolysis, and *vice versa*. In the case above the hydrochlorid of cocain would probably be broken up as follows: The acid radical will be negatively charged and will go to the positive pole, and the alkaloid will be positively charged and will go to the negative pole. As it passes into the tissue it will doubtless meet ions of oxygen coming toward the positive pole, and at once there will be formed in the tissue a new product, a compound of cocain. Now, it is a fact that only a small per cent. of the molecules will ionize or dissociate; hence we see why there has been practically no difference in the effect we observed from using a saturated solution of cocain or a one per cent. solution.

Here again we can make our deductions both from clinical observations and theoretical calculation.

I have observed the following results by applying the cocain solution as stated above:

First. In nearly fifteen hundred cases of which I have kept a

record (and in many a complete record of the amperage, the voltage, and the resistance at both the beginning and the ending of the operation; also the time, size of cavity, and medicine used), the per cent. of perfectly successful cases has been between 95 and 100; and of late, with the increase of experience, all cases have been successful on the second application, if not on the first. Of these fully one hundred were cases in which the pulp was entirely removed at the time, and in about two hundred more the pulp was drilled into and partly removed and a devitalizing agent used to complete the destruction.

Second. In almost all cases of single-rooted teeth the pulp was entirely removed at the time.

Third. No sensation of pain was felt from the devitalizing agent applied after using cataphoresis.

Fourth. Not a single case, as yet, of a dead pulp from the use of cataphoresis.

Fifth. No difference has been noted in the time required for different concentrations of cocain or any other agent.

Sixth. The average time required was about thirteen minutes.

Seventh. The amount of current tolerable in a case of unexposed healthy pulp is determined by the effect of the current on the pulp-tissue and not on the dentin.

Eighth. The resistance through the wet dentin varies all the way from a few thousand to five hundred thousand ohms.

Ninth. The amount of current tolerable has been found to vary from one two-hundred-thousandth of an ampere to two-thousandths of an ampere, the average being less than two ten-thousandths at the beginning of the operation and four ten-thousandths at the finish. Of course, where pulps were devitalized a very much stronger current was used for the finish, but seldom more than that amount was used where the continued life of a pulp was expected.

Tenth. There are no constant symptoms that will give any indication of the amount of current flowing. Each case has a different pain limit; hence the *absolute* necessity of using a milliamperemeter.

Eleventh. No effect has ever been noted in the tissues beyond the tooth except where a very strong current was used; then slight periostitis.

What deductions can we make from the above clinical results? And the foregoing laws of nerve excitability, the laws of osmosis, and the laws of electrolysis?

We know that when a solution of cocain is supplied to the dentin of a tooth under the positive pole, with a negative elsewhere, we do get anesthesia not only of the dentin, but of the pulp-tissue, if applied long enough.

Will the current alone produce this condition? Answer, *No.*

Then it is not the current that does the work.

Will the medicine alone produce this condition? Answer, *No.*

Then it is not a simple osmosis.

Does the current so applied produce any change in the cocain solution? Answer, *Yes.* It cannot pass through it except by changing it.

Is there a transmission of matter in this solution under these conditions by simple osmosis? Answer, probably very slight.

Is there a considerable transmission of matter at all? Answer, *Yes,* by the migration of the ions.

Do these ions produce currents which carry the unchanged medicine with them? Theoretically, yes, but practically, *very* slight.

Are these currents produced in both directions? Answer, *Yes.*

Can an osmosis be produced from a negative to a positive pole? Yes, in some solutions. (An analogous phenomenon is observed, though by a different force, when a globule of mercury is placed between two electrodes in water; the globule goes to the positive pole.)

According to the older theories, there was supposed to be a physical force exerted in some manner by the electric current applied in this manner, and this theory has its advocates yet. There is a newer theory, however, which is made by its introducer to explain all the phenomena. Its author is Nernst, of Göttingen, Germany. He maintains that there is no transmission of matter except the ions themselves. Of course, the accumulation of the ions at the electrodes will produce a difference of concentration of the products they form, which would set up osmotic currents. These are granted, but there is a different opinion as to their strength, which is probably extremely slight.

Now, to follow this same argument in this connection, if it is

the force of osmosis on which we are dependent, what will be the effect of the new molecules of hydrochlorid of cocain formed in the pulp-tissue by electrolysis on the osmosis from without? Of course, if such is formed it would diminish the difference of concentration within and without the pulp-chamber, and by doing so would lessen the force of the osmotic pressure, which is in direct proportion to the difference of concentration at different points. In this case it would not seem that the current was helping the process. It is certain that we are not dependent on a difference of concentration for the development of the force that carries the cocain through the tissue. Do we know that a medicament can actually be forced into the pulp at all? Answer, yes, in many ways. I have put sulfate of morphin with the cocain, and after extracting the pulp on a broach been able to detect the morphin by the nitric acid test under the microscope. I have killed a frog in twenty minutes with sulfate of strychnin with the current, when neither the current alone nor the medicine alone, left for a considerable time, produced any noticeable effect. I do not believe the medicine was in any case carried in as the original chemical species, but was changed by electrolysis; and further, with the conditions under which we use cataphoresis, I believe the forces upon which we are dependent are the dissociation of the molecules and the increased energy of these dissociated products. These ions, by their increased energy, by their migration, and by the new chemical species they form, are capable of producing just such phenomena as are produced in cataphoresis, as will be seen by this simple experiment.

The final goal is, of course, to diminish the time. I do not believe this will be done by seeking directly for a substance that has a high osmotic pressure, but rather by seeking for a reaction that will produce the most active ion. It is true, however, that substances that have a high osmotic pressure have good conductivity. Since the amount of current we can use is limited by the pain limit of the tissue, and the amount of electrolysis is a constant expression of the strength of current, of course the amount of chemical energy we can liberate is fixed, and we cannot hope to change this unless we can change some of the laws of either *physiology, electrolysis,* or *chemistry.* We have left these unfixed conditions to modify,—viz, to select the ions with greatest

migration velocity, and which themselves, or the compounds which they will form, will produce the greatest physiological effect upon the tissue for the same unit of concentration in the tissue. There is no reason why great advancement should not be expected along this line, and it is my opinion that when it does come it must come along this line.

I am indebted for valuable references to Professor Morley, of the Western Reserve University; Professor Miller, of the Case School of Applied Science, and Professor Herdman, of the University of Michigan.

DISCUSSION.

DR. RHEIN: As far as my investigations with the cataphoric diffusion of medicinal agents have gone, they bear out very closely, from a practical standpoint, what the author of this paper has presented to us this evening. The only possibility of an issue with what he has given us that I could perceive is the question of the means by which the medicinal agents are passed through the different substances,—whether that is accomplished by direct physical pressure or by the liberation of some of the molecular elements. Now, I do not intend to discuss that portion of the paper, because further investigation will be necessary before the truth or the incorrectness of this theory can be established. I have been doing some work in the effort to produce, if possible, anesthesia of the dentin and pulp by means of osmotic pressure, without the use of the electrical current, but my investigations have not proceeded far enough to enable me, as yet, to form any conclusion. There is no question but that if the pressure theory is the correct one we shall be able to obtain the anesthetic effects by other means than by the electrical power alone. The practical results given us in this paper are the things of greatest interest. I refer especially to the importance which the author of the paper attaches to the use of the milliamperemeter in cataphoresis. In some extensive investigations which I have made in different sections of the country to ascertain the manner in which the different instruments were put into use, and the way in which efforts were being made to sell them to the members of the profession, I have learned that a great many men are endeavoring to make use of this very valuable means without the aid of a milliamperemeter. This cannot be too strongly condemned, for the very excellent reasons that the author of the paper has given us.

The other interesting point, from a practical view, is found in the ratio of data which he gives us from the numerous cases that he has so carefully observed. The reading of these cases *in seriatim* will certainly be of great interest to us.

My own impression is that the solution of the problem of a reduction of the time limit will be found, to a great extent, in our ability to increase the amount of potential force that we introduce, and at the same time increase the amount of amperage that is forced through the tooth. I think the means of accomplishing that will be found in an improvement in the anode ends that are introduced into the cavity itself. I think the great mistake has been in using points altogether too narrow in diameter, which renders them ineffectual to diffuse a sufficient amount of current in a given space. I think the end of the anode should be as large as it is possible to introduce into a cavity of a given size. This is the line which I believe will, if followed out properly, enable us to reduce the time limit. We have all heard of the anesthetization of dentin in a very few minutes, but whenever I have endeavored to follow up any such experimentation by personal investigation I have always found that the depth of surface that was anesthetized was not sufficient to produce complete anesthesia. The reports of these cases of anesthesia in a few minutes are due, very possibly, to the imperfect cleansing of carious cavities that some of the profession are accustomed to.

The PRESIDENT: We should be glad to hear from Dr. Custer on this subject.

DR. CUSTER: I have been so much interested in the paper that I have not thought of making any remarks upon it. I have not a single thought in shape for presenting, but I wish to say that the paper is one which all of us who are interested in cataphoresis should read carefully when it appears in print. It is worthy of our careful consideration and study. It is a monumental paper on the question now so prominently before the profession,—that is, as to the physiological action of cataphoresis.

DR. CASSIDY: Mr. President, I do not know much about this subject. I indorse the position taken by Dr. Price with respect to the cataphoric action of drugs depending largely upon electrolysis and the play of the affinities of the ions or radicals produced by the current. The point that struck me as rather novel was

that the sensory nerves were poorer conductors than the muscular tissue, and that when the current is applied to the pulp the nerve portion of that organ is less affected by the current than the other constituents.

In regard to the resistance between the two poles, when there is a current passed between what are called the two poles, those two points in the current are poles no longer; they are the beginning and ending of another kind of conductor. We take it for granted, it seems thus far, that it is the anode or positive pole that must be presented to the part in connection with the medicine employed. It seems to me that if the ions are the active principles of the medicament, then in order to obey the laws of electrolysis—if this process depends upon electrolysis—we must use whichever pole will repulse the ion that we wish to act upon the tissue which we wish to penetrate. If we use the positive pole, it is only the electro-positive ion that will try to penetrate or get to the negative pole. If we wish to bleach a tooth with peroxid of hydrogen, and we wish to get the full benefit of the cataphoric action, better results will be obtained by using the cathode, or negative pole, in the tooth, in connection with the peroxid of hydrogen, instead of the positive pole. Why? Because the oxygen set free is so highly electro-negative of itself that it will seek the positive pole; and if the positive pole is placed to the cheek, the substance causing the discoloration of the tooth will be more rapidly oxidized, there will be more penetration of the medicament, and the result will be more effectual than if the positive pole is used in the tooth. The oxygen, indeed, will not react any better than it will without the current until it receives a higher potential than the positive pole itself.

As the paper stated, the electrolytes must be compound in their nature. They must be in a fluid condition, also, in order to act as electrolytes. A mere solution of iodin is not an electrolyte, but a compound of iodin with some element like potassium makes an excellent electrolyte. In such a case the laws of electrolysis are called into play. The iodin will act toward the positive pole as oxygen will; therefore, the negative pole should be the one employed in connection with the solution of potassium iodid instead of the positive pole. An element such as chlorin is not an electrolyte at all. Even in aqueous solution it would be the water that

would act as an electrolyte in that case. An elementary body is not an electrolyte.

Now, in regard to the uses of certain compounds, such as sulfuric acid: If you wish to use sulfuric acid as the drug in question, and wish by cataphoresis to cause it to penetrate farther than by mere external application, in that case it is not the ions or radicals of the acid that act on the tissue. You get the effects of the acid itself. Why? It is because the sulfuric acid is decomposed. The electro-negative ion called sulphion, SO_4, penetrates and mates at the same time with the positive ion of water,—namely, hydrogen. What is the consequence? The decomposition of the acid by the electric current sets free the two ions from the acid hydrogen and SO_4. Now, as they reach the points where freedom takes place, hydrogen will escape at the negative pole and the SO_4 at the positive pole; and when so escaping at the end of the series of electrolytes, the sulphion takes up with the hydrogen again that it finds in the water present and forms sulfuric acid, which will then react upon the tissue.

There are a great many points in that paper that could be considered and indorsed, but I do not feel like saying any more tonight.

The PRESIDENT: I think the members would be glad to hear from Dr. St. George Elliott, of New York.

DR. ELLIOTT: Mr. President and gentlemen, I indorse all that has been said in regard to the very great value of this paper. It is of very great value, for the reason that the gentleman who wrote it has taken the trouble to go very deeply into the matter. Most of us are quite satisfied to make practical demonstrations of certain theories. We formulate them in our minds, and then make certain practical applications of those theories; but there are very few of us who are competent to go into the matter as the author of this paper has done. I think that in order to properly discuss the paper we should have it in our hands, and read and study it, and then experimentally examine the facts, because, you know, the great weakness of dentists—because we are all busy men—is to receive the statements of others as absolute truth. Consequently we should not only take the paper and study it, but we should take some experimental evidence of our own to substantiate the theories.

I, in common with others of the profession, have used the different apparatus with a fair amount of success. My experiments have been of too indefinite a character to permit me to formulate them in any way, but I think it is a field upon which we can all usefully bestow a great deal of time.

The PRESIDENT: Dr. Patterson, will you have anything to say upon this subject?

DR. PATTERSON: Mr. President, I am very sorry to say that I know nothing about the subject—not enough, at least, to enable me to discuss the able paper in an intelligent manner. I have electricity in my office for motive power only. If anything goes wrong I call up the electrical expert, and he comes up and fixes it. I am pretty busy, and I have not been able to give time even to look into the elementary principles of electricity. I thank you for the compliment.

DR. PRICE: It is a very interesting question which the gentleman who first spoke raises—whether or not the nature of the electrodes would aid at all in shortening the time it would take. The time is dependent mostly on the pain limit; hence it will not make a bit of difference what combinations we get in the circuit of a constant current. The same amount of current flowing through that nerve will produce absolutely the same sensations. For instance, I have taken a patient and had him shut his eyes. I would take six volts, we will say, with a definite amount of resistance, and just as soon as a certain decimal, a very small fraction of a milliampere, was reached, he would tell me every time by the feeling. I made a score of combinations up to one hundred and eight volts with high resistance, and that man would tell me by the feeling, when I came to the same point, within the two-hundred-thousandth part of an ampere. He would get the same definite sensation. That would answer the question, to my mind, whether a difference in the combinations of electrodes or the size of the electrodes can make any difference. The pain limit is dependent entirely upon the amount of current flowing. The relative distribution of the current to the dentin can be varied by the nature of the electrode, though if the cotton around it is thoroughly saturated with the medicament the current will be quite evenly distributed if the resistance of the medicament is low. The metallic electrode should not touch the dentin.

GENERAL ADDRESS.

Relations of Chemistry to Dentistry.

By J. S. CASSIDY.

MR. PRESIDENT AND GENTLEMEN:

The subject allotted to me for this occasion is one which I approach with feelings somewhat akin to those of the timid youth who, for the first time, tells the story of his love, knowing full well that the loved one possesses many attributes of rare perfection, inherited from a long line of distinguished ancestors. The heroine of our story is dentistry, and I take it that her most illustrious progenitor is chemistry.

Investigation of the laws which were supposed to govern observed natural phenomena was one of the favorite pursuits of learned men from the earliest historic times. Reasoning from effect to cause as time progressed led to many useful discoveries, probably in the same ratio to intelligence and the laws of supply and demand as obtains in the affairs of this day and age.

The development of the ancient art of alchemy along practical lines was a leading civilizing influence on the people as they gradually emerged from their simple surroundings into a clearer perception of the comforts which can be obtained from changing material bodies into more desirable or needed conditions. The inhabitants of the deserts of Lybia were, in the olden time, inadequately supplied with common salt; their alchemists accordingly manufactured a substitute from camel's dung and named it Sal Ammoniac,—"Salt of Ammon,"—in honor of Jupiter Ammon, whom they worshipped. Herein the Arab chemists exhibited a commendable commercial spirit, whereas their Greek and Roman

contemporaries labored somewhat more in the field of pharmacy, by extracting from both mineral and vegetable sources numerous medicinal agents, thus in their practice balancing the mercenary by the professional spirit.

Whatever of dentistry existed in those days must have partaken of the benefits derived from the important part played by alchemy in general therapeutics.

According to Dr. Ebers, many branches of science flourished wonderfully in ancient Egypt, and were practiced by specialists of the priestly order. "Our physicians," said the King Amasis to his visitor, Crœsus, "are only permitted to treat one part of the body. We have aurists, dentists, and oculists, surgeons for fractures of the bone, and others for internal diseases. By the ancient priestly law a dentist is not allowed to treat a deaf man, nor a surgeon for broken bones to treat a patient who is suffering from a disease of the bowels, even though he should have a first-rate knowledge of internal complaints. This law aims at securing a great deal of real and thorough knowledge,—an aim, indeed, pursued with a most praiseworthy earnestness in all branches of science." "I came to Egypt," wrote the Sybarite, "to consult a dentist. That rude fellow, Aristomachus, of Sparta, however, knocked out the defective tooth, and so saved me from an operation the thought of which had often made me tremble. On recovering consciousness I found that three teeth had been knocked into my mouth,—the diseased one and two others, which, though healthy, would probably at some future time have caused me pain."

During the long interregnum between the ancient Oriental and the modern European civilization there was such continuous robber warfare and rapine, that the arts of peace, outside of the quiet cloister, were not encouraged. There was no dental art worthy of the name, and comparatively little chemical research. In fact, modern chemistry, as a science, may be said to date its birth from the discovery of oxygen; and, coincidently, dental science must claim its origin as beginning about the same time. It would be superfluous and beyond the scope of our present purpose to note the advances which these divisions of human effort have made since then. They are both concomitants of higher civilization. "Show me," said Tyndall, "the country where the greatest quantity of sulfuric acid is used and I will tell you that its people are, above

all others, the most generally enlightened." In like manner we may say that the people of any community where dentistry flourishes are of a higher order of intelligence than are those found elsewhere. My own town, by the way, contains its full quota of excellent dentists.

Dentistry is and should be cosmopolitan. It appropriates with due permission facts and methods from the humblest as well as the most exalted occupations, and in return gives back to them a large per cent. of the benefits received. Metallurgy, molding, sculpture, surgery, medicine, physics, and chemistry have been appealed to not in vain, and as a consequence the accomplished dentist could point out to willing youth the best means of becoming experts in these separate vocations.

Of all these sciences that of chemistry is the most universal, since it has no limitations; all forms of matter and force must own its sway. In its domain secrecy, mystery, and charlatanism are no longer tolerated, and all who will may partake freely of the benefits it has conferred and will continue to confer in increasing ratio upon mankind.

To chemistry our profession is indebted in that it prepared N_2O, by which means, in after years, Dr. Horace Wells, a dentist, might be permitted to introduce anesthesia, the greatest boon ever conferred on suffering humanity.

And here let me say that it does not follow that a man must thoroughly understand every department of the noble science in order to appreciate truths in chemistry which may be daily useful to him in our profession. Even a limited knowledge of the principles of chemistry enables the operator to administer that anesthetic intelligently, knowing that N_2O supersedes the normal process of oxidation in the body and prevents the ready elimination of its products, inducing thus the anesthesia by rapid formation and retention of CO_2, which fact of itself suggests the proper remedies for overcoming the tendency to asphyxia which necessarily follows the inhaling of the gas.

Dentists, as a rule, are not indifferent to nor ignorant of chemical processes, nothwithstanding that our friend, Dr. Crouse, asserted that there was not a single dentist in this country who could make an accurate quantitative analysis of any dental amalgam; whereas hundreds might be named who could do so, if it were necessary.

Indeed, there are many men, not professional chemists, who are able to do excellent work along the lines of chemical discovery and manipulation. The recent studies of the chemical and physical properties of amalgams are of inestimable value to every dentist who thankfully takes advantage of the information derived through the labors of Dr. Black.

Moreover, not to mention the innumerable pharmaceutical preparations, our zinc oxid cements may be brought in evidence, and as some of us are sure that fillings of these materials are disposed to disintegrate more at the cervical portion than elsewhere, we also think we know the true and only cause of that unfortunate disposition, in that the part under or near the gum margin is a favorite point for alkaline fermentation, such as the production of ammonia, resulting in the inevitable abstraction by it of the electronegative substance of the cement. Some may be inclined to consider this brief allusion to cause and effect as "only a fine-spun theory," but it is not; it is as susceptible of proof as any problem in mathematics.

We cannot, as dentists, escape, even if we so desire, the claims of the science of chemistry upon our earnest attention and study, for on every hand we are compelled to admit the insidious influence of its affinities to be the exciting and efficient cause of the principal diseases with which we have to contend. Happily the study of chemistry, while acquainting us with these potent influences, also points out to us within the sphere of the same science the means at hand to combat them most beneficently provided, if we will but study and apply them.

No member of this, as the late Dr. Atkinson termed it, "Excelsior Association of Dentists," will doubt the culminating discovery of Dr. Miller that at least lactic acid is developed in the mouth by the presence of bacteria, and the materials necessary to their support, and also to the play of chemical affinities at the point of carious destruction; and, further, that the destroying agent acts molecularly with as definite results as pertain to any other natural phenomenon. Some years ago, when the so-called "germ theory" of disease was introduced there were not a few who received the innovation with satisfaction, because they would not or could not understand, and therefore approve, the chemical theories of Watt. It is now, however, accepted beyond question that there is no con-

fl:ct between the two theories; tnat bacteria are a necessary factor in fermentation, and that their only trysting-places are in the midst of extraneous material susceptible to that process, the elements of which must obey the laws of their affinities; and if, for instance, among other compounds, destructive and otherwise, lactic acid, as proven by Miller, is developed in contact with a tooth, destruction of that part will proceed molecule by molecule; so that, while it is probable that teeth, like other organs, yield to an increased non-resisting influence of a "periodic law," dental caries is *per se* a disease of purely chemical propagation. From this latter viewpoint the relations between chemistry and dentistry are not of the most amicable character, notwithstanding which the science whose unseen minions are directly responsible for the existence of our principal enemy will inevitably furnish us with more effective weapons of defense than we as yet possess.

No wonder that dentists are perhaps unconsciously more interested in chemistry than are the members of the mother profession; at least it would so appear by personal contact with them, and by impartial reading of medical and dental journals. One of the former lately, to refer to a single example, expressed its surprise that any two acids could neutralize each other; and then went on to say that by mixing one part of acetic acid and one and one-half of carbolic acid a neutral compound will result. Any tyro in organic chemistry knows that phenol is not an acid, but on the contrary is an alcohol; and that an alcohol and an acid combined will produce an ester and water:

$$\underset{\text{Phenol.}}{C_6H_5HO} + \underset{\text{Acetic acid.}}{C_2H_4O_2} = \underset{\text{Phenyl acetate.}}{C_6H_5C_2H_3O_2} + H_2O$$

Perhaps the worst chemical blunder ever made, officially, in a dental journal occurred a few years ago in a foreign periodical, wherein the editor, with the characteristic stupid arrogance of *his* kind, criticising a brief scientific description of ordinary combustion, wherein light is an essential accompaniment, mentioned the rusting of iron as his *beau ideal* of that process. We could forgive him for this were it not that he presumed to "know it all" on all questions of a similar nature.

It goes without saying that a fore-knowledge of certain rules in chemistry is a great aid in adapting means to ends when anything new in that line appears; as, for instance, in cataphoresis, we were

told at first that the positive pole must be used in contact with whatever drug was employed, whereas it is well known in electrolysis that the radicals or ions of conducting compound liquids separate in a perfectly definite manner, the positive radical being attracted to the cathode, and the negative to the anode; so that we will likely obtain better results by selecting anophoresis when we wish greater penetration of a strongly electro-negative radical. A duly certified list of comparative positive and negative classes of radicals has been known for many years, of which we are welcome to take advantage; and in return for all these favors would it not be an act of courtesy on our part to approve, when occasion permits, certain changes in chemical nomenclature, adopted through official international committees appointed for the purpose by the most influential scientific bodies? Our journals, it is almost unnecessary to say, are editorially fully up to and are indeed in advance of the times; but we see too often in reports of discussion in our local societies, and in some of our latest text-books, names of things and terms that shock the sensibilities of euphony and truth. Take, for example, *potassium iodid;* is not that name more pleasant to the ear than iodide of potash,—especially when we realize that the compound contains no potash whatever?

We have been surfeited for a long time with cocain hydrochlorate, and lately with eucain hydrochlorate; although a generation ago it was decided that acids like hydrochloric (HCl), hydrobromic (HBr), etc., whose electro-negative radicals are elementary, confer names on salts which terminate in *ide* (the final "e" has been eliminated); therefore the name of every salt of such acids should end in "id," as, cocain hydrochlorid. It is only those acids which have compound negative radicals that give names to salts ending in "ate" or "ite," as the case may be. Sulfuric acid (H_2SO_4) forms sulfates; sulfurous acid (H_2SO_3), sulfites; chloric acid ($HClO_3$), chlorates; chlorous acid ($HClO_2$), chlorites, etc.

Life is too short to nominate for consideration at this time more than just one other frequently misapplied word; and that word is "density." We use it—do we not—as a synonym for hardness in the structural substance of teeth, instead of in its true meaning, *i.e.*, specific gravity? Ice is harder and more compact to a cutting instrument than is liquid water; but it is less dense. The diamond, among the hardest of bodies known, is only three and a half times

as heavy as water; while pure gold is comparatively soft, although more than nineteen times as heavy as the standard,—water. It is not possible to believe that the specific gravity of a tooth has anything to do with predisposition to disease, or even that compactness of calcium constituents is a condition that presents a physiological barrier to decay. While perhaps these matters may appear of small practical importance, yet surely as we claim to be devoted disciples of pure science, we have no right to trifle with accepted nomenclature.

DISCUSSION.

The PRESIDENT: Gentlemen, you have listened to a very able paper, which is now open for discussion. Dr. Barrett, will you lead off?

DR. BARRETT: I should be only too happy to do so, Mr. President, if it were not mainly devoted to a field which I have not specially cultivated,—that is, chemistry. I have no expert knowledge of chemistry, and I am all at sea on the subject of the mistakes which Dr. Cassidy says are so often made; hence I do not feel that I can do more than to commend the paper very highly. I might say this, Mr. President: We all aim to be known as educated men. We claim a scientific status, and yet some of our representatives cannot spell, and an exemplification of that now stares you in the face, suspended from yonder pillar. Sometimes the most ludicrous blunders occur in text-books, publications, and journals. I am very glad indeed when a man of some erudition, some knowledge, calls attention to our shortcomings. We get up on the fence and flap our wings and crow, and proclaim that we are the very tip-top blue-blossom of educational and scientific development, but we do not always comprehend the very insecure foundation upon which our claims in some instances rest. I am as prone as is any one to indulge in these vaporings, and I am glad to have my attention called to my own shortcomings. I never learn anything from the man who says, "You know it all; you are a good fellow. I desire to substantiate everything you have said; I am your echo." But the man who shows me that I am mistaken, who tells me I am wrong, and, what is worse, perhaps, proves it, that man is my master, my teacher, my benefactor; hence I am glad to hear such papers as this, and to profit by them.

The PRESIDENT: We should like to hear from Dr. Guilford or Dr. Peirce.

DR. PEIRCE: I can express my great pleasure in listening to the paper. It was instructive to me, as I think it was to every one present, for it is scholarly and true in its scientific conclusions.

The PRESIDENT: We should be glad to hear from Dr. St. George Elliott.

DR. ELLIOTT: Mr. President, I have nothing in particular to say, except to commend the paper; but I should like to ask Dr. Cassidy what his views are in regard to Dr. Black's recent statement. The Institute of Stomatology of New York has within a few weeks sent out circulars to a large number of dentists, asking their views on Dr. Black's point, which is that the density of a tooth has nothing to do with its tendency to decay. Of course, the answers have not yet come in. I should like to have Dr. Cassidy state to us his view of the matter.

DR. CASSIDY: If I answer the question of Dr. Elliott at this time I shall have to do so on general principles, not knowing anything of the transactions to which he alludes. It seems to me that we need not know nor care anything about the density of a tooth. The density of a tooth is its specific gravity, the comparative weight of the tooth. Therefore the density probably has nothing to do with the predisposition to decay. If we mean hardness, compactness, and all that, it may have a good deal to do with resisting decay. If Dr. Black meant density in its true meaning, I think he is correct. There is no question about it in my mind.

DR. ELLIOTT: I should like to state that Dr. Black stated distinctly, in the paper he read before the New York Odontological Society, that in speaking of the density of a tooth he did not consider the question of hardness to cutting instruments, which seems to me to explain the whole thing.

The PRESIDENT: Dr. Taft, may we have a word from you on this subject?

DR. TAFT: Mr. President, I only heard a part of the paper, and if I had heard it all perhaps I could do nothing more than to ask a question or two. I will not attempt even to do that now. I am very glad indeed that we have men in our profession who can so thoroughly discuss these subjects. I have no doubt the other

points in the paper were as well presented as those I heard. Such papers as this enter upon the marrow and the pith of the question involved in this subject—that of chemistry. I think this body would do well to encourage such efforts in every way possible, and thus stimulate the study and investigation.

DR. H. A. SMITH: Mr. President, like the other members, I can only commend the paper. Those of us who know Professor Cassidy are aware that in what he says in public or anywhere he is very careful to be on solid ground. He made one statement to which I should like to call attention, and that is as to the manner in which cement fillings disintegrate at the cervical border, or his accounting for it. Very often, on the floor of the Association, we hear the statement made, and we also read, that cement fillings stand just as well at the cervical border as they do at any place in the cavity. Dr. Cassidy accounts for the solution at that point by the development of the alkaline reaction. I only call attention to this fact that, if Professor Cassidy is correct, then all these statements by those who say they make permanent fillings with cement, fillings that will stand at the cervical borders and under the gum, are incorrect, and the authors of those statements are very much mistaken. Only very lately a gentleman said that he never had any difficulty of this kind, and that if his fillings failed at all it was away from the border of the cavity, under the gum. Now, who is right about this? The reaction at this border of the cavity is usually alkaline, and we have the development of ammonia, which will dissolve any cement fillings of the kind known as oxyphosphate.

DR. PATTERSON: Mr. President, I have been very glad to listen to this paper. All of us who are trying to teach know the dread with which students in college approach the study of chemistry. It is, of all the studies they have, the most disliked. I can scarcely tell why it is so, unless it is because we have no dental teachers of chemistry. Our chemistry teachers are largely found in the other profession. It has also been found by myself that those students who come into our college as graduates in pharmacy, who are competent chemists, or fairly so, are the best students we have. When the National Association of Dental Faculties gave graduates in pharmacy credit for one year they did a good thing.

I should like to say just one word in regard to what Dr. Smith has said about the disintegration of oxyphosphate fillings at the cervical border. If it is proved, by carefully conducted experimentation, that these oxyphosphate fillings will and do disintegrate from alkalinity at that portion of the filling, then the statements of Dr. Cassidy may be substantiated. I have made a great many experiments myself in fillings along these lines, and I will tell Dr. Smith that so far as I am concerned a cement filling, if properly mixed and inserted, does not perceptibly disintegrate in alkaline solutions in any length of time, or any condition which you can represent as closely as you are able to do out of the mouth. Representing in this way any alkaline solution that it is possible to find in the mouth, it will not affect a properly made oxyphosphate filling. This is my experience. I am not a chemist myself. The only thing I can say about this is what I have tried again and again and again. I have tried both acid solutions and alkaline solutions many and many a time, and if you will do it yourselves, it seems to me you will come to the same conclusion, practically, that I have come to.

DR. H. A. SMITH: Mr. President, I did not expect to make this issue. I think we got into this through telling our individual experiences. I doubt very much whether you can procure, outside of the mouth, the conditions which are found in the mouth, and I do know, from my own observation when I have made my very best efforts with that material, that that portion of the filling which rises above the cervical border will be intact when the other will be obliterated and destroyed, because we have frequently at that line a deposit of the nitrogenous foods which in fermentation (putrefaction) produce an alkaline reaction. If we ate only flesh all the time these fillings would not be put in at all, because they would not in any sense be permanent. The conditions at the cervical border are such, then, that if fermentation takes place we have an alkaline reaction. Those conditions cannot be duplicated outside of the mouth, in my judgment; hence any test outside of the mouth would not be a conclusive one. Let me appeal to every member present if it is not true that many times, and as a rule, if the filling fails at all through chemical solution, it is at the cervical border. It may waste for other reasons, but this, in my judgment, is the vulnerable point, and we can give no assurance

of permanency, especially in a mouth which is neglected and where we must inevitably have putrefaction, giving an alkaline reaction from nitrogenous classes of food. I should like to hear Dr. Cassidy elaborate a little on that.

DR. BARRETT: Mr. President, I should like to ask Dr. Smith a question. He says that the fermentation is an alkaline fermentation. Do I understand—

DR. H. A. SMITH: I should have used the word putrefaction instead of fermentation.

DR. BARRETT: I was going to ask him whether it was acetous fermentation, vinous fermentation, or butyric fermentation.

DR. H. A. SMITH: It is putrefactive.

DR. BARRETT: You may get ammonia from putrefaction, but not from fermentation.

DR. H. A. SMITH: Yes, I know the *tendency* of fermentation is to produce acids; of putrefaction, alkalies. My use of the word was merely a slip of the tongue.

DR. CASSIDY: As I understand it, the distinction between putrefaction and fermentation is a distinction without a difference. Putrefaction is alkaline fermentation, while what we call fermentation is of an acid nature; but practically they both depend upon the action of bacteria upon extraneous matter.

DR. BARRETT: What about vinous fermentation?

DR. CASSIDY: Vinous fermentation is also fermentation of an acid character. All forms of fermentation, if we restrict the term, imply that they end in the formation of an acid, butyric, acetic, etc. Putrefaction is used, as distinguished from fermentation, to indicate the fermentation of nitrogenous matter, which produces ammonia and its derivatives.

As I understood Dr. Patterson, he said that he has experimented out of the mouth with alkalies upon oxyphosphate cement. So have I. While these experiments do not prove exactly and absolutely the same reactions that occur in the mouth, they do prove certain facts. We must acknowledge that ammonia is developed in the mouth by alkaline or putrefactive fermentation—I will adhere to that term. Take an oxyphosphate filling, properly made, carefully placed in a tooth outside of the mouth in a perfectly dry condition, and let it stand in a dry place for an hour, if you wish, or two or six hours,—longer than you would in a

practical case. Then place it in a five per cent. solution of common aqua ammonia, let it stand over night, and the next morning you will find that the filling has disintegrated, all of it, unless it is a very large one. The oxid of zinc will be a precipitate, and the phosphoric acid will have united with the ammonia. That is a positive, practical experiment. If ammonia is developed in the mouth, this reaction will take place in the presence of oxyphosphate fillings.

DR. BARRETT: I am glad to have had the distinction made between putrefaction and fermentation, and the meaning made a little more clear than it usually is. Of course, we are well aware that the organisms producing ferments and those producing putrefaction are different species altogether. There has been a deal of loose construction of those terms, I think, in my own mind, as well as in the minds of others. We have commonly understood that putrefaction is destructive fermentation, with the evolution of offensive products. That, of course, is due to the nitrogenous product which is present. We have not clearly, even among some who are best informed, drawn the line between putrefaction and fermentation. The organisms which produce them are of different classes, but all belong to the fungi, and to the same general classes of the fungi. The inorganic or the digestive ferments are of an entirely different character. There has been too much of looseness in classification and comprehension, and I am glad that Professor Cassidy explained the distinction between the two. I wish he would make the explanation even more full than he has done, because, as I say, there is a great deal of confusion in regard to it.

DR. H. A. SMITH: If we concede that these fillings disintegrate at the cervical border, I should like to ask Professor Cassidy why it is so general, as compared with their disintegration at other points,—why it is that we have the alkaline product of putrefaction at this point? Perhaps if we have the chemistry of it, it will be a little more clear. Why do the nitrogenous foods lodge at this point, or remain in contact more than at other points? An oxyphosphate filling is worth scarcely anything at all, I find, under the gum-margin.

DR. CASSIDY: In such cases the finishing of the filling has a great deal to do. When, in finishing a filling under the margin

of the gum, a little roughness or imperfection is allowed, which is more apt to be the case here than elsewhere, probably it sets up an inflammation of the gum. When this process goes on,—using the term inflammation,—the process of fermentation called putrefaction follows, for inflammation of living soft tissue is concomitant with putrefaction, and the characteristic or typical ending of putrefaction is ammonia, or some of its derivatives. The ptomaines, for instance,—those poisonous alkaloid bodies, derivatives of ammonia,—are developed at that point more than elsewhere; probably more by the inflammation in the gum than by the *débris*, or food or mucus that may be lodged there. Extraneous matter is more apt to be lodged there, of course, than elsewhere on the surface, but I think the formation of alkalies is due more to inflammation, producing this putrefactive change, than to any other cause.

DR. BARRETT: Let me call attention, Mr. President, to the white, cheesy deposit with which Professor Smith is undoubtedly familiar. That, it seems to me, accounts for the thing,—the white, cheesy deposit,—a soft mass which is found at the gingival margin upon the teeth, and whose putrefaction or fermentation may produce either an acid or an alkali, according to which of these processes prevails. It seems to me that this may account for the change referred to.

SECTION I.

PROSTHETIC DENTISTRY, METALLURGY, AND CHEMISTRY.

Principles of Force and Anchorage in the Movement of Teeth.

PAPER BY C. S. CASE, OF THE SECTION.

IF there is one thing more important than another in the science of regulating teeth, it is a mind that is well trained in the simple laws of physics, with the ability to practically apply these laws to the invention, construction, and management of regulating appliances.

In the voluminous literature and teachings upon the subject of orthodontia and dentistry in general, there is little to be learned of these most important basic principles. In our endeavor to become a great profession and completely disassociate ourselves as professional men from the fearful calamity of being classed as tradesmen and mechanics, there has been an unfortunate tendency to underrate the value of certain branches of knowledge that lie at the very foundation of dentistry, and which should form the only true basis to scientific training for almost everything we undertake as dentists.

In contradistinction to the course commonly pursued by most teachers in the department of orthodontia, I occupy no time in lengthy histories of cases in practice, whose specific procedures and final results seem to be for the purpose of proving the utility of the methods and implements employed, because I believe it to be far more important to train the minds of students: First, in certain

broad and general principles relative to artistic and harmonious relations that will apply to all cases; second, how to scientifically apply force for every variety of movement of a tooth in any position, which will equip him, from a mechanical standpoint, for the movement of teeth, and, finally, for the complete management of the most difficult cases of irregularity.

Certainly this is the only true and scientific foundation for that display of individual thought and ingenuity which almost every case commands. He is now, if ever, able to invent something that will be applicable to the particular case in hand, and which may differ in certain particulars from anything that has ever been used or ever can be used again. Furthermore, if correct artistic, physiological, and mechanical principles are employed for the regulation of teeth, results are quite as reliable as most things in exact sciences, and therefore teaching along this line does not necessarily require to be founded on the experiences of practice.

In my teaching I dwell at considerable length upon the laws which govern the activities of force and the mechanical advantages of different methods of applying it in the practical movement of teeth.

I treat a regulating apparatus, together with the teeth to which it is attached, as a machine. The best definition of a machine is that it is an instrument interposed between a moving power and a resistance or work, with the view of changing the direction of force or otherwise modifying it.

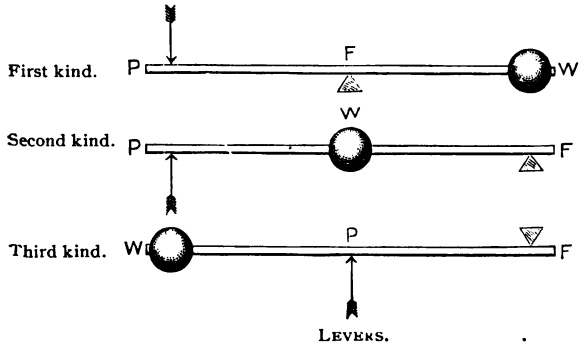
The important difference between an ordinary and a regulating machine is that, with the former, *power* and *work* are the only important factors. A manufacturer or person engaged in the use of machinery is interested as to how much wood or coal, through the medium of its product, steam or electricity, will produce a certain result in the form of work. Means for taking care of the force of reaction is amply provided for in the substructure or the inertia of the machine itself; whereas with a dental regulating machine power supplied by the operator counts for naught, while the factor, reaction, on fulcrum and anchorage, referred to in Newton's Third Law of Force, is of the most vital importance. This law is: To every action there is an equal and contrary reaction. And this equal and contrary force of reaction, which of necessity is sustained by other vital tissues, should be neutralized, either by

reciprocatory action upon other irregular teeth that require movement in an opposite direction, or by so distributing this force through the medium of a static anchorage that it will do the least harm to teeth in proper position.

I said that I considered the teeth grasped by a regulating apparatus as a part of the machine itself,—as levers, if you please, doing work principally upon the bony structure surrounding their roots.

The ordinary lever is a rigid bar or inflexible rod resting upon a fixed prop called the fulcrum, and having power and weight disposed at some two other points. The different ways in which the three factors, power, weight, and fulcrum, can be disposed gives rise to three kinds of levers. (See Fig. 1.)

FIG. 1.



LEVERS.

Here again, as with machines in general, physics in computing quantities deals only with power and weight or work, exemplified in the one general law of levers,—*i.e.*, "Power and weight are in the inverse ratio to their distance from the fulcrum." Nothing is said of the force of reaction or the force sustained at the fulcrum; whereas, with a tooth considered as a lever, the action at the fulcrum, as will be shown, is as important to us as at the points known as power and weight; and, moreover, it is important to keep in mind approximately the relation which it bears to these factors.

While it is never possible or necessary to accurately calculate these quantities, still, in order to arrive at the rough estimate desirable, a clear conception of the mathematical methods employed under the laws of physics, especially those relating to levers, is

very important. This can easily be approximated with levers when we remember that the force exerted or sustained by the factor situated between the other two, at equilibrium, is equal to the sum of the other two, be it power, weight, or fulcrum. That is why a lever of the second kind is always chosen where great force is required at the expense of motion.

Again, in the typical lever the fulcrum is always considered a fixed point, but we are aware that there are a number of implements employed in mechanics that exert force according to the principles of levers, though in construction they differ in certain particulars from every one of the three kinds. Common examples of this are all forms of the "pulley, and the wheel and axle powers."

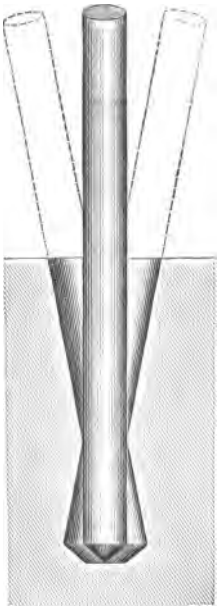
There is, furthermore, a not uncommon kind of lever in which the points of weight and fulcrum, in their action upon each other, are more or less interchangeable; each acting as a fulcrum for the other, with varying stability and relative energy governed by the velocity of the moving power and the relative length of the power arm.

An example of a lever of this kind is an oar of a row-boat. In proportion to the velocity of the moving power exerted by the rower, above the possibility of the water to get out of the way of the blade, the oar becomes a lever of the second kind and the boat or work moves forward. But if the velocity of the moving power is not sufficient to overcome the inertia of the boat, the only work that the oar or lever can be said to accomplish is the movement of the yielding water in front of the blade, with the fulcrum at the oar-lock,—or the action of a lever of the first kind.

If at any time you should drive a four-foot post one-half its length into clayey soil of uniform quality, and then take hold of the top of the post and move it back and forth with a view of pulling it out of the ground, you would be working a lever which combines the qualities of the first and second kinds, or one like the oar in which the so-called areas of fulcrum and weight each act as a fulcrum to the other. (See Fig. 2.) After pulling the post out of the ground, if it were possible for you to make a transverse section of the soil for the purpose of examining the shape of the hole you had made, you would find the upper two-thirds a V-shaped opening tapered down to the diameter of the post, the lower third spreading out to an inverted V.

Please bear in mind and do not lose sight of the fact that the object of this study of levers is to obtain a clear conception of the relations of the *three* forces, and principally the relation between the forces exerted at points or areas of F and W, that we may be able to determine more accurately the probable force exerted at the cervical and apical portions of a tooth, with power applied at different points upon the crown. As the post was forced in one direction the soil in front of it along the surface area would become impacted or thrust to one side, the whole acting as a lever of the

FIG. 2.



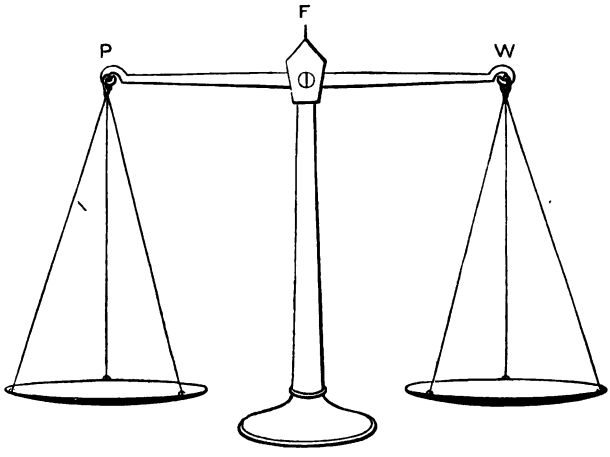
second kind with fulcrum at the lower end. At some point along its length, however, it would cease to move in the direction of the applied power, the very resistance of the soil over the surface area of work causing it in turn to act as a fulcrum and the whole as a lever of the first kind, with work or movement at the lower end in the opposite direction.

The reason that the upper area of work is twice that of the lower may be found in an examination of laws which refer to the relation of the three factors of levers. Considered as a lever of the first

kind, if the fulcrum or surface area of the ground is exactly in the center of the post, the force exerted upon it would be equal to the sum of power and weight, or twice as great as that exerted at the lower end or area of work. Again, when considered as a lever of the second kind, weight or work now being between and at an equal distance from power and fulcrum, it would be forced to receive a pressure equal to the sum of power and fulcrum, or twice as great as that exerted at the lower end or fulcrum area.

I am in the habit of illustrating these important principles to my students by examples of some simple forms of levers of the first and second kinds. (See Fig. 3.) The beam of balance scales is a lever of the first kind. The support or central standard

FIG. 3.



is the fulcrum, with points of power and weight at the end attachments for the pans. It can now be seen at once that when the beam or lever is at equilibrium the fulcrum sustains the sum of power and weight, and this would hold true of any lever of the first kind at whatever intermediate point between power and weight the fulcrum is placed. When the fulcrum is exactly in the middle of the lever, as with the example of the post lever, the fulcrum receives twice as much force as is exerted at weight, and consequently the post would move through the soil at the surface of the ground twice as far as at the lower end in the opposite direction.

An example of a lever of the second kind may be a rod or pole supporting a weight carried by two men. (See Fig. 4.) If the points at which the two men—whom we may call P and F—grasp the pole are four feet apart, and the weight is a pail of water weighing thirty pounds swung in the center of the pole, each man would exert a force equal to fifteen pounds. In other words, the force exerted at weight exactly in the middle of a lever of the second kind at equilibrium would be twice that at the fulcrum.

FIG. 4.

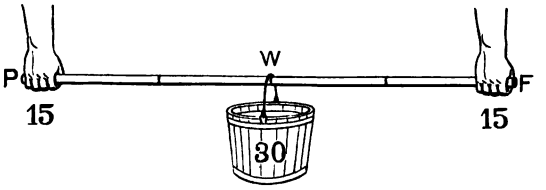


FIG. 5.

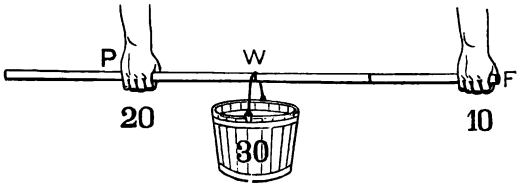
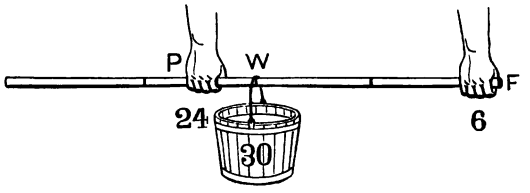


FIG. 6.



Here again we have the same result as that shown by the action of a lever of the first kind.

Now, if you please, note the change in the relative magnitude of force exerted at fulcrum and weight when the length of the power arm is shortened. (See Fig. 5.) If P grasps the rod one foot from the pail, we have a three-foot lever with P exerting twice as much force as F, which may be proven by the rule of levers,—*i.e.*, "Power and weight are in the inverse ratio to their distance from the fulcrum."

Power arm of the above lever—three feet—is to W arm,—two feet,—as weight—thirty pounds—is to P, or twenty pounds, which leaves ten pounds to be sustained by F. Therefore, the force exerted at weight in this lever is three times that at the fulcrum.

Again, if P grasps the rod six inches from the weight he exerts a force equal to four times that of F, determined by the same law. (See Fig. 6.) Here the force exerted at weight is five times that at the fulcrum.

When we apply these rules to our post-lever (which I have chosen to illustrate on a large scale the action of the same character of force applied to a tooth) we can see that the inverted V-shaped opening caused by the lower end of the post moving in the opposite direction from the applied power may be changed quite decidedly in area by applying the power at different points along that portion of the post above the surface. For instance, when power is applied at the top of a four-foot post imbedded one-half its length in the ground, the movement at the lower end in the opposite direction will be one-half that at the surface of the ground in the direction of the power. When power is applied one foot from the ground, or at a point one-half the length of the exposed end, the movement at the lower end in the opposite direction will be one-third that at the surface, and when applied six inches from the ground (or as near to the alveolar margin of a tooth as the gum will permit) the movement at the lower end will be one-fifth that at the surface.

While teeth differ in shape from each other and from the post-lever I have described, and while their alveolar surroundings do not present a uniformity of resistance to their movement, and therefore while we cannot calculate force and motion with mathematical accuracy, still the fact that they are imbedded one-half their length in a yielding substance and subject to the frequent application of force for the correction of irregularities, the only way by which we can approach an exact science in the application of power for their movement is to consider them as levers propelled by a machine doing work on the tissues in which they are imbedded.

When power is applied at one point to the crown of a tooth at right angles to its long axis, it becomes a lever with combined qualities of the first and second kinds; it is one more than the

other in proportion to the relative difference in the resistance between cervical and apical portions. And while the relative proportion of movement at these points will be governed largely by the stability of their bony surroundings, it may be influenced considerably, as with the post-lever, by the position upon the crown at which power is applied. For instance, in the construction of an appliance for the retrusion or retraction of the incisors with a traction wire extending from molar anchorages, if we wish the least movement possible of the roots in the opposite direction, the wire should rest upon the incisors as near to the gingival margins as the

FIG. 7.

FIG. 8.

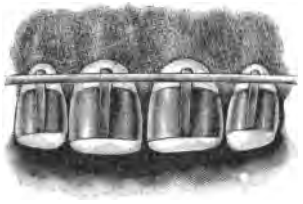


FIG. 9.

FIG. 10.

gums will permit. I usually solder to the bands upright bars which extend to the highest points of the exposed faces of the crowns. Grooves or rests are cut at the upper ends of these for the wire, enabling it to span the interproximate gingivæ. (See Figs. 7 and 8.) I frequently extend these bars above the gum-margins, as shown in Fig. 9, in order to apply power that is equivalent to direct force upon the roots at points above the margins of the alveoli, and I wish to say that I find these procedures of the greatest importance in arriving at results for which they are designed.

It is not necessary for me at this time to multiply descriptions of methods relative to other teeth and conditions where this impor-

tant principle may be employed, further than to say that whenever it is desired to avoid producing an abnormal inclination of the crowns of teeth in the direction of the applied power, it is important, and nearly always possible, to take advantage of this or some other equally effective mechanical principle.

On the other hand, whenever in the movement of a crown under the application of a single force it is desired to move the root in the opposite direction, the force should be applied as near as possible to the occluding border. This is especially applicable in those very common cases of protruded crowns of the upper incisors, with a retrusion of the roots, the teeth often assuming a decided labial inclination with the production of a depression along the upper portion of the upper lip.

A tooth becomes a lever of the third kind when the power is applied at or near the cervix with the establishment of a mechanical fulcrum near the occlusal portion of crown, forcing work or movement of the entire root in the direction of the applied power. (See Fig. 10, model contour appliance.) This is one of the most important and practical principles in dental and facial orthopedia, and one, moreover, to which I am indebted for nearly everything I have accomplished in the development of esthetic facial contours. Instances where this principle may be used to advantage are almost limitless, either in the form of two forces exerting a regulated power in opposite directions for the purpose of tipping the root in its socket, or as power restrained by an independent fulcrum with the view of moving the entire root in one direction.

In a paper presented at the Tri-State Dental Meeting at Detroit, in 1895, I gave the following explanation:

"The limited area upon which force can be applied to a tooth compared to that portion covered by the gum and imbedded in a bony socket has made it next to impossible, with all ordinary methods, to move the apex of the root in the direction of the applied power; nor could this ever be accomplished with force exerted in the usual way at one point upon the crown, however near the margin of the gums it be applied, for the opposing margin of the alveolar socket must receive the magnitude of this direct force, and in proportion to its resistance it will become a fulcrum, exerting a tendency to move the apical end of the root in the opposite direction.

"But if in the construction of the apparatus a static fulcrum is created independent of the alveolar process at a point near the occluding portion of the crown, while the power is applied at a point as far up on the root as the mechanical and other opportunities of the case will permit, the apparatus becomes a lever of the third kind, the power being directed to a movement of the entire root in the direction of the applied force."

This proposition is made plain by reference to the diagrams. In Fig. 11 let A be a point upon a central incisor at which force is applied in the direction indicated by the arrow, then will the opposing wall B of the alveolar socket near its margin receive nearly all of the direct force; and in proportion to its resistance will there be a tendency to move the root in the opposite direction.

FIG. 11.

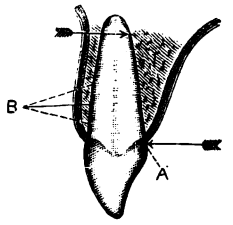
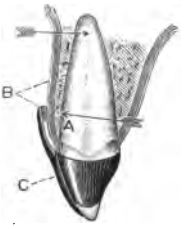


FIG. 12.

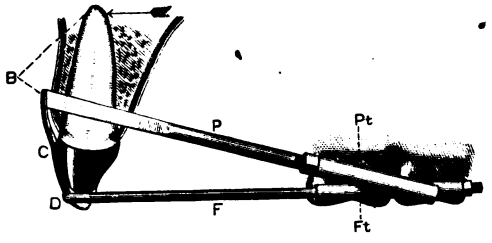


This proposition will also hold good even if we apply the force at A, Fig. 12, or as far up on the root as may be permitted by attaching a rigid upright bar, C, to the anterior surface of the crown, the only difference being that we distribute the direct force over a greater area. But if, as in Fig. 13, we attach to the lower end of C a traction wire or fulcrum bar F, and further enforce the mechanical principles of our machine by uniting its posterior attachment to the anchorage of the power bar P, we will have neutralized our anchorage force materially and created an independent static fulcrum at D. Our apparatus now will distribute its force over the entire root, and give us complete direction and control of whatever power we put into it. The entire tooth can be carried forward bodily, or either end can be made to move the more rapidly. The force thus directed to the ends of the roots will have an increased tendency to move the more or less yielding and cartilaginous bone in which they are imbedded.

An apparatus for moving the roots of the anterior teeth in a posterior direction is constructed quite similarly, the direction of the two forces being reversed.

In that branch of my teaching, entitled "Construction of Regulating Appliances and their Management," I endeavor to arrange the work systematically according to the distinct mechanical principles involved in the scientific application of the required force. I divide the whole subject under this head into two general divisions, entitled, respectively, Action and Reaction. Under the head of "action," which pertains exclusively to the movement of malposed teeth by the direct action of force, I take up: First, the movement of crowns in every direction; second, the movement of roots in every direction, with or without the movement of their crowns; third, rotating or turning of teeth on their long axes; fourth, intrusion and extrusion, or the gradual forcing of teeth in or out of their sockets.

FIG. 13.



The second main division of the work, entitled "reaction," pertains to the management of the oppc sing force to action. This I divide into: First, reciprocating or movable anchorages, describing methods for utilizing the force of reaction in the movement of other malposed teeth; and, second, stationary or static anchorage appliances.

I do not mean by this that I confine the teaching of this work to a single branch at a time to the exclusion of all others, but I endeavor to blend them into each other, illustrating the principles, as I progress, with practical cases.

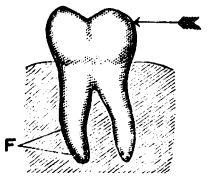
In a single paper of this kind it will be impossible for me to give the special underlying principles for the application of force in all the branches of this work, but in order to give you an idea of its

scope I will, as briefly as possible, describe the principles involved in the construction of static or stationary anchorage appliances.

This branch applies to those cases of irregularities where the force of reaction to the work of regulating must be sustained by tissues which surround teeth that we do not wish to move. As these are usually the posterior teeth, with the power applied to them either in a posterior or anterior direction, I will confine my remarks to that class of anchorages.

If force is applied at one point on the crown of a molar tooth in an anterior direction, the principal fulcrum is a certain area of the anterior wall of the alveolus of the mesial root in the vicinity of the apex. This being the immovable point around which all other parts must rotate in movement, it is often found that the relative shapes of the other root or roots are such that they are lifted almost directly from their sockets, their membranous attachments being

FIG. 14.



the only bar they present to the process of tipping the crown. It would seem that the three roots of the upper molars would enable these teeth to present the greater resistance to this movement, but I have found that they tip quite as easily as the lower molars.

Fig. 14 is a lateral view of a right lower molar. If force is applied to the crown in an anterior direction, at a point at or near the occlusal surface, the probable fulcrum area would be at F, and as the crown moves forward the distal root is found to be lifted from its socket with slight impingement along its walls. If the force is in the posterior direction, the natural curve of the mesial root, which is quite common, would offer still less resistance to the tipping motion of the crown.

In contemplating the construction of a molar anchorage appliance that will permit the least possible movement of the included teeth, the principal object therefore should be to so construct the device that the great tendency to tipping of the crowns will be

prevented. If this is fully accomplished and the tooth or teeth are held in an upright position, the applied force will be evenly distributed over the entire anterior or posterior surfaces of the alveoli for all the roots, increasing the stability of the anchorage to an incalculable degree. If the appliance is loosely attached to the teeth, or permits the slightest hinge movement, as would arise from a removable crib or a single uncemented band that encircles two or more teeth, there would be nothing to prevent this tipping tendency; though such an anchorage might be sufficient for many purposes if it is attached to a sufficient number of teeth and the applied power is always less than their combined natural inertia. But instances frequently arise in the regulation of teeth where it is eminently desirable to obtain an anchorage of the greatest possible stability. When considerable force is required to reduce an irregularity, two or three teeth should be included in the grasp of the anchorage appliance. The addition of a second tooth to the anchorage will not only double its stability, but incalculably increase it, by the support which the two teeth can be made to give to each other by a proper construction of the appliance. In its construction German silver or platinized gold bands should be selected that are six to ten thousandths of an inch in thickness (or Nos. 34 to 30 B. & S. gauge), and as wide as the teeth will permit. When these bands are so dered and properly contoured to perfectly fit the crowns, take a plaster impression of them in position, after which carefully remove them, place them in the impression, and fill with Teague's or any good investing material. This will hold them in proper relative position during the soldering process. Solder should be flowed between the bands, uniting their approximal surfaces and filling the V-shaped spaces on either side. To more perfectly reinforce the stability of the appliance, fit and solder to the lingual surfaces a flattened piece of No. 16 wire; after which the tube or tubes are to be attached for the power bars or traction wires for the movement of the anterior teeth. In attaching the tubes, the advantage of applying the power as near to the gingival margin as possible should be remembered.

When such an appliance is fitted and cemented to the teeth, it will hold them rigidly in its grasp in an upright position. If the bands are thin and narrow, or the apparatus is not sufficiently re-

inforced by the solder and otherwise, the slight yielding of the material under great strain will allow the teeth to tip and soon break loose from their attachments.

Instances frequently arise where only one tooth can be used for an anchorage on one or both sides of the mouth. These teeth not being supported by adjoining teeth will readily tip, if not properly sustained. In fact, a molar tooth that is allowed to tip will offer but little more resistance to force than a bicuspid, but if sustained in an upright position it will be impossible to force it bodily through the process with any ordinary power. This is especially true of the lower molars, which, when tipped to an anterior or posterior inclination, are readily forced from their imbedment or partially lifted out of their sockets; but if held in an upright position the two broad roots will resist immovably a large amount of force. When a single isolated molar is used for an anchorage attachment the band should be wide and thick, fitted and cemented as carefully as a crown, with rigid attachments for inflexible extensions. However perfect the band and its attachments, if a flexible traction wire is used to transfer the power, no obstruction is offered to the tipping tendency of the molar. The same is true with an inflexible power rod, if the band is thin, narrow, and yielding, or in any way movable upon the tooth, or if the power tube is short and loosely fitted to the rod.

When great immobility of a single anchorage tooth is required, use for banding material German silver or platinized gold, No. 30 gauge, and as wide as the tooth will permit. When these are contoured and fitted, solder the power tube at the gingival margin. (See Fig. 15.) This should be sufficiently long to permit reinforcing it at either end with solder to the full width of the tooth, and large enough to carry a power rod that will be inflexible. Where it is possible, the power tube may rest above the gingival margin, soldered to an extension plate that is fitted or swaged to the surface of the crown and so shaped as to freely clear the gum.

If the power tube is extended forward to the first bicuspid and its anterior end allowed to rest upon a narrow projection soldered to the bicuspid band, it will add greatly to the stability of the anchorage.

It will be seen that any tendency of the molar to tip forward will carry the anterior end of the tube almost directly toward the

root of the bicuspid, the movement being prevented by the rest. (See Fig. 16.) Nor will such a device offer any special obstruction to the movement of the bicuspid, the rest sliding along the tube.

It is often more convenient to sustain the anchorage with a flattened bar soldered to the lingual aspect of the molar band which extends to and engages with rests upon the bicuspids. This is especially applicable where it is desired to reduce an anterior protrusion with a small flexible traction wire encircling the teeth. Frequently the lower cuspids are anteriorly prominent, the incisors

FIG. 15.

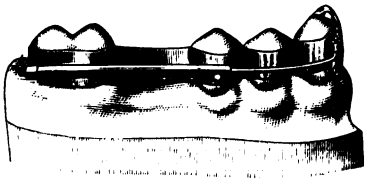


FIG. 16.

are crowded, irregular, and somewhat extruded, but not protruded, —in fact, they are frequently retruded, presenting one of those cases where the extraction of a bicuspid is indicated, were it not for the fact that the first molar on one or both sides is missing. Here the anchorage for forcing back the cuspids with a buccal bar may be sustained with a tube, instead of a flattened bar, which extends along the lingual aspect of the bicuspids, but not supported upon rests. An inflexible rod is fitted into these tubes (one on each side), and engages with hooks soldered to the incisor bands. (See Fig. 17.) If the incisors are retruded, the ends of the bar may be threaded for nuts at the anterior ends of the tubes to force the incisors forward, the two forces being reciprocatory. It will be seen that any forward tipping of the molars will be prevented by

the incisors sustaining the anchorage support, the force tending to intrude the incisors.

A similar device is applicable for children with a decided lower protrusion, where the early extraction of the first bicuspids has been indicated, and with only the immature first molars that can be used for an anchorage to reduce the protrusion. (See Fig. 18.)

FIG. 17.

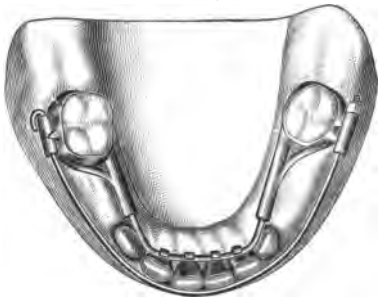
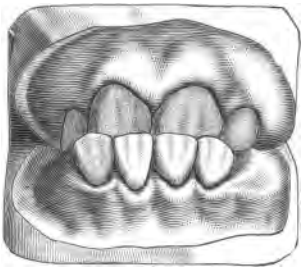


FIG. 18.



The lingual supporting tubes should be sufficiently large to allow the ends of the wire that engage with the incisors to easily glide into them as the incisors are forced back with an encircling traction wire.

The same device is also applicable to the upper teeth when the occlusion will permit of its attachment.

DISCUSSION.

The PRESIDENT: Dr. Jackson, will you open the discussion on this subject?

DR. JACKSON: Mr. President, I have been very much interested in the paper just read. As I understand it, Dr. Case has

been describing to us his method of anchorage, and not claiming any specially new features. My system of anchorage is so entirely different that I think I should leave it to the gentlemen who are interested in more general methods of anchorage to speak upon this subject. In the first place, I would not, in my practice, wedge the teeth apart and put four thicknesses of metal or two or more separate collars between them in order to gain an anchorage. Those teeth must be moved usually to get an anchorage, which has to be done by wedging. The wedging need not necessarily excite an inflammation, but I do not believe in the practice of interfering with teeth in this manner that are to be used for anchorage. Some persons may say, What would I do in order to gain a firm anchorage? There are several methods, besides those I have previously described, of obtaining a perfect anchorage-attachment to molars. One of these I have used for several years. It is to strike up a plate, or rather make a cap, to pass over the molars and over the bicuspids, if they are not to be moved. This cap I fit accurately to the lingual and buccal surfaces, being able to contour it much more closely than could be the case with a collar passing around the tooth, the grinding-surface of the molar being a little larger than its neck. The doctor says that he always contours his collars nicely. It must be understood that it is very difficult to fit and cement a collar perfectly to a tooth that is tapering toward the gum, like a molar. In the method I speak of now, "a cap of thin metal," fortified by a thicker bar of plate metal, is soldered to the buccal and lingual surfaces with suitable attachments and cemented firmly to the teeth. If the second molar is not fully erupted, or is just coming through the gum, it can be made to assist the anchorage by passing, in some instances, a piece of metal back of it, under the margin of the gum, and another through, between the teeth,—either a thin piece of flat metal or wire,—having them soldered to the cap, and then cementing the whole firmly to the teeth. That is probably one of the best methods we have of assuring an anchorage that will not permit the molars or bicuspids to tip forward or backward when pressure is put upon them. I am pleased with the way the doctor has presented his paper, and appreciate the principles that he has intended to convey and the scientific description given of the uses of the lever, which all should understand thoroughly before begin-

ning the work of orthodontia. I have but little difficulty, in the method that I practice, in the way of detrimental movement of the teeth used for anchorage, because the first thing I do, when beginning the study of the mouth and the model, is to determine what influences will be exerted, and to adopt methods that will prevent their detrimental movement. It is certainly irrational to believe that we can move at one time several teeth, any considerable distance at least, with a single tooth on either side of the arch for anchorage. We must adopt methods that will fortify the anchorage.

I understand that Dr. Case has excluded the plate from his practice. In many instances I get great benefit from the use of the plate covering the roof of the mouth, as for contracting the anterior part of the arch; the plate assists the anchorage by pressing against the anterior palatine surface.

DR. NOBLE: I rise with some diffidence to speak upon this subject. It is a subject in which I am intensely interested, and I have pursued it for some years, studying a great variety of cases. I have been very much interested in the principles enunciated so clearly and distinctly in the paper read here this morning. The principles here illustrated are undoubtedly correct. They should, and must, be thoroughly understood if one is to be successful in correcting these irregularities. No one should undertake the correction of irregularities until these mechanical principles are well understood. Secondly, each and every case should be carefully studied, by careful impressions of both upper and lower teeth, before anything further is done. I am an enthusiastic admirer of what is known as the Jackson system. There has never been a time, in my entire practice of over forty years, when I have not had from one to five cases of teeth-regulation going on. In going over the ground, and after using very many of these appliances that we have had, I have come to the conclusion, from the past three or four years' experience, that the "Jackson system" will cover a larger number of cases, with greater simplicity, than anything else we have ever had. I doubt very much whether the members of the profession generally understand the simplicity and efficiency of that system. If they did study and understand it as I have seen it illustrated in cases of my own within the past few years, I am sure they would look upon it with favor. I have

admired the exquisitely made apparatus which has been passed around here to-day, but I say without fear, believing I can substantiate my statement with models which I have here, and which I shall be happy to show, that the results in all of these cases can be accomplished with much more simple apparatus than the specimens exhibited here, however correct in principle they may be. I should be very glad to pass my models around, except that I do not like to have them go out of my hands. You must remember that models showing the original appearance of the teeth can never be taken again after the correction has been made, and some of the models have already been broken in handling. Many of the members of the Maryland and Virginia and District of Columbia Societies have seen the models and know something of the work that I have been doing in that direction in the past few years. I shall be glad to show these models to any gentleman who will call upon me.

DR. MCKELLOPS: This question deserves a great deal of attention from our profession. It is a subject that a majority of the members of our profession are neglecting. It is one of the most difficult things in the world to regulate teeth, and many mouths have been ruined in the regulating. I have had the pleasure of meeting Dr. Case in different societies and under various circumstances, have seen his models, and know something of the amount of work he is doing. The results that he accomplishes are wonderful, not by taking out teeth, but by understanding the anatomy of the jaws and face, so that he can change them in almost any direction. The members of the profession ought to give this subject more attention than the most of them ever have given it. There is plenty of this work to be done, as we all know when we recall the number of crooked faces, crowded jaws, and everything of that kind. Now, the results which are being accomplished in the hands of such men as this are doing us a power of good throughout the country. I hope every one here will take an interest in these things and see what this gentleman has done.

DR. JOHN B. RICH: Mr. President, this paper deserves our earnest consideration. In exhibiting apparatus for regulating the teeth before societies, the mechanical principles upon which they are formed and applied are seldom clearly explained when they are presented, in consequence of which many ingenious

devices do not receive the attention they deserve. In this presentation the diagrams clearly illustrate the method by which the principles governing its construction can best be applied, not only to the regulation of the teeth, but also to avoid as much as possible injury to the parts that are used as the fulcrum of the apparatus.

The last illustration shown by Dr. Case (the long lever), having for its object the preventing of the tipping of the tooth or teeth that are to form the fulcrum of the regulating apparatus, is certainly the most ingenious and simple device for that purpose I have ever seen, and it is evident it will accomplish the object for which it is designed. The dissemination of correct principles upon which regulating apparatus should be constructed is a matter of great importance to our profession, and for this very able effort in this direction the author should receive our most hearty thanks.

DR. OTTOLENGUI: Mr. President and gentlemen, I arise with some hesitation to discuss this paper, because of the fact that this is my first year as a member of this Association; but ever since these theories were first advocated by Dr. Case I have hoped for an opportunity of discussing them with the originator of the apparatus present. I have preferred to do that rather than to appear in print in opposition to some of his theories, because I recognize the fact that I might be in error, and I believe that the publication of erroneous views only encumbers our literature; whereas, if I express opinions now which the author of the paper can refute, the refutation will appear in print at the same time with the report of my antagonism of his methods.

In the first place, admitting the marvelous ingenuity displayed by Dr. Case, and granting him due credit for the conception of this appliance, I do not concede the general applicability of it which he claims. I think he has said that this applicability is almost unlimited. If by unlimited he means that the methods and principles advocated may be adapted to a great variety of cases, I concede that. If he means, however, that they can be adapted to a great number of patients, I deny that.

The use of abutments which are movable, and which must be sustained in position during the progress of the work, is the chief weakness of this system, and the very great ingenuity which Dr. Case has shown in the various devices for sustaining his anchorages is in itself an admission of this weakness. When we must

depend upon a number of "posts in the mud" to move other posts in the mud, we are in a position which is fundamentally erroneous.

A common error which has been made in the past, in resorting to this sort of anchorage (to which we are very often driven), has been to utilize as anchorages teeth in the posterior part of the mouth without making any effort to support them, either by attachment to anterior teeth which are not to be moved, or by some such ingenious method as Dr. Case shows of attaching them to teeth which are in transit.

I believe that Dr. Jackson was one of the first to publish the records of efforts of this kind. In my own experience, whenever I have been called upon to make use of a third attachment,—that is to say, to find a fixed point in the anterior portion of the mouth to which I unite my anchorages, utilizing a band, let us say, around a central incisor,—the greatest difficulty which I have had to overcome has been the sacrifice of the space occupied by the band.

Dr. Case's method, however valuable, depends upon many bands around the teeth and the sacrifice of a great amount of space, all of which, if I were regulating the teeth, I should feel called upon to finally close up. I may be doing the author an injustice, but it would seem that he does not object to leaving spaces between teeth, because he has passed around among us a retaining appliance in which spurs of metal pass between all of the teeth. Such a case coming into my hands, according to my ideals, would require regulation. I should wish to discard such a retainer and close up the spaces.

Next, I wish to refer to Figs. 7 and 9. The argument is made here, with truth, that by holding the incisive end of the tooth fixed, and obtaining a point of resistance or fulcrum higher up on the tooth, the root of the tooth can be moved; but when it is claimed that the fixture shown in Fig. 9 moves the fulcrum higher up than Fig. 7 I fail to see it. In Fig. 7 we find that to obtain a fulcrum as near the gum as possible the doctor has attached a small arm, which rests upon the tooth-substance near the gum-margin. This of course places the fulcrum as high as possible on the exposed portion of the tooth. When, however, he claims that by lengthening this arm, as shown in Fig. 9, he moves the fulcrum higher up, I cannot admit that he is correct. The force exerted at the end of this arm will be distributed through it to

its attachment to the band, and the fulcrum point will be exactly the same as in Fig. 7.

Of course, I can understand that in many instances it may be advantageous to lengthen the arm in this manner, in order to change the direction of the force. I merely claim that the fulcrum point, or resistance to pressure on the tooth, is the same in each.

Returning to the question of general applicability, we find that the whole resistance for the movement of the teeth in transit must come from the posterior teeth. It must also come from posterior teeth which are to support bands. Since this scheme was first promulgated I have had between twenty and thirty cases of protruding arches pass through my hands, and I have not found one case in which the posterior teeth would have offered a sufficient resistance to the force needed in moving the anterior teeth backward. Nor have I seen many instances in which the posterior teeth had sufficiently erupted to have made it possible to make them sustain bands under much pressure.

It is because I am unwilling to wait until the child is matured and all of its bones hardened, in order to take advantage of teeth which have fully developed in the posterior portion of the mouth, that I prefer to begin the retraction of the jaw as early as possible: as early as the eighth or ninth year, if the patient comes into my hands. I would begin long before the cuspids have appeared through the gum and bone. I prefer to undertake to carry the unerupted cuspids back with the process while the bones are soft, and I could not do that by any such method as is outlined by Dr. Case, especially with short sixth-year molars, the twelfth-year molars unerupted.

In some of the models which have been passed around I observe that the anchor-bands have been supported by two molars on each side, which would indicate, at least, that the patient had reached the fourteenth year, or else that an unusually early development had occurred.

Of course, I must admit that there are exceptional cases where this appliance might be utilized. A young girl was brought to me this summer who was only eleven years old, but the twelfth-year molars were fully developed, all of the teeth being long and offering a fair opportunity for a trial of Dr. Case's method; but

the very fact that this case is exceptional places the method, to my mind, rather among the curiosities of literature than among methods the general adaptability of which would make them useful to the ordinary practitioner, such as the Jackson method has proven to be.

Moreover, I frequently find in these mouths very small central incisors and very tiny lateral incisors, and teeth that are conical in shape, especially in the molar region. Such mouths would certainly be unfavorable.

I would like to say just one word about the fixture with which the doctor has so well explained how ingeniously a solitary anchor-tooth may be held. He tells us that this fixture will prevent the tooth from tipping. What will be the result? Without entering into an extensive discussion of the physical principles involved, let us look at it from a more mechanical standpoint. We have the molars fastened, let us admit, so that they cannot tip, and we have a force distributed around the arch which is expected to carry back several teeth, the resistance being these two teeth, which have been made less solid in their sockets by the removal of teeth in front, leaving empty sockets. Since these anchor-teeth cannot tip, why should they not move forward bodily? In my opinion, with such an appliance, they will move forward bodily.

And, beyond and above all, the greatest objection to the use of the posterior teeth as the resistance to the force which makes any extensive movement of the anterior teeth is that we undermine the very dependence upon which we must rely for final retention of our regulated arch.

I have had regulated teeth come to me with the retainer accurately fitting, and yet the protrusion returning. The dentists who had done the regulating argued to those patients, "Your teeth are all right; your retainer fits." So it may, but the very necessity which tells us that we require a retainer recognizes the tendency of these front teeth to return to their original position, and that tendency indicates a force, and that force requires a fixed resistance, and if the fixed resistance is not great enough, the entire set of teeth will move, the retainer and all; consequently the tremendous advantage of a somewhat old method, introduced so long ago now that it seems that some of us have

come to almost forget it,—that of utilizing the back of the head as a resistance in moving the teeth, thus leaving the posterior teeth solidly fastened in the jaws, affording anchorages for the final retention of the teeth which have been moved.

DR. GUILFORD: Mr. President, I am one of those who have always admired the work of Dr. Case. I am glad that we have in the field of orthodontia so able and so excellent a workman. He has done a great deal of original work, and we must give him credit for doing things that others before him have not done. If they have thought of them, they certainly have not accomplished them. One of the very important points that he has elucidated to-day—the matter of the compensatory movement whereby he holds one portion of the tooth while he moves the other—is something that is grand in principle, and is beautifully carried out in the construction which he has shown us. So far as my knowledge goes, he has been the first one to do that, and he deserves our everlasting gratitude for it. I am not here to praise Dr. Case. He knows what I think of him. He also knows that when the occasion seems to warrant it I am always free to criticise, to find fault, to make suggestions contrary to those that he has put forth. So, to-day, while he has shown us the principles upon which this line of work should be conducted, and has so beautifully explained the fundamental principles of physics applicable to this work, I think he has made one or two errors, to which I should like to call his attention. Dr. Ottolengui has anticipated me a little. In the first place, in the matter of levers, I do not think his illustrations represent levers at all. A lever must have a fulcrum somewhere. These have none. I therefore do not look upon them as proper illustrations of the lever principle. They are simply illustrations of methods for raising a weight. You do not raise it with a pulley, of course, but you do not raise it with a lever. You do not raise it by means of a fulcrum, something to bear upon; consequently they are not illustrations of levers.

Referring to the diagram (see Fig. 9) in a case of this kind, where you make an extension from a band upward, and apply your power here (indicating), on the outside or the inside, you get the application of your power just where the base of the rod is, and that is exactly here (indicating). In this case it is there (indicating); so that, as Dr. Ottolengui has said, when you use

a force of this kind you gain nothing in the way of the application of power. In having a wire to attach your bow-wire to, that will clear the gum, you gain a physical advantage,—there is no question about that,—but so far as power is concerned, you certainly gain nothing at all; so that, while I do not object to it, I simply object to the claim that you get greater power up there. To get the power that Dr. Case would like to have, you would be obliged to have a band around the tooth at that point, which is a physical impossibility; so that, as I said, the advantage of it is in convenience, and nothing else, and this bar here would have just as much effect at the top portion of the band as it has at the one above.

In regard to some of the other appliances, the same thing was brought out in connection with the molar bands. Dr. Case showed us an illustration of this kind, a wide band around a molar, and then he advocated setting the tube up above. We say "up" when we mean nearer the gum. Making an extension here (indicating), he seemed to think you would get an advantage by running this along beyond the gum. You get only so much as is attached to the band. You might as well attach the tube there (indicating), and leave it there. That does not give you any advantage whatever.

It is an important matter, this process of counteracting the power applied in one direction by power applied in the opposite direction. That is perfectly correct, and that is a thing for which I said we ought to give due credit to Dr. Case for accomplishing. In regard to his illustration of a post, he explained to us very nicely and at a good deal of length why it was that, in moving a post of that kind, up to a certain point you had movement of the tissues nearest to the surface in one direction, and how beyond that point you have a movement in the other direction, a resorption of the tissues nearer the apex. That is all very correct and right, but there is one point that I think he did not call attention to, as I wish he had done, for he understands it as well as any of us, and that is, that in the movement of a tooth of this kind we must consider the outer layer of the bone,—the cortical layer,—which is a very dense layer. If we want to tip this root in the direction in which it has been tipped, and to exaggerate or increase it, we should take advantage of that cortical layer, and in

pressing here (indicating) it would act as the fulcrum, and this would be the weight upon the lever that would cause it to move in that direction; but when we do not want the tipping, when we want to move it back as nearly as possible without any tipping, we should cut away this cortical portion of the bone. That would assist very materially in the work. I do not doubt that Dr. Case does this in cases where he wants to move the teeth back bodily. I simply wished to mention it. In regard to the matter of bands, Dr. Case lays great stress upon the fitting of them; upon drawing them so close and burnishing them so exactly to the tooth that they shall adapt themselves to the teeth as much as possible. I have never felt the importance of this. I believe in the band not occupying any more space than it should; but when you get a band that adapts itself so closely to the tooth you have very little room for cement, and it is the cement that holds the band. You cannot fit a band to a tooth so accurately that it will stay of itself. For resisting all the power you apply to it you must depend upon the cement. Therefore I prefer not to fit my bands too closely, and to rely on the cement to hold them in place.

One other point. Dr. Jackson spoke of it, and so did Dr. Ottolengui. That is the fitting of so many bands upon different teeth that they occupy or take up the valuable interdental space. When you have a number of teeth that you want to move inward,—it does not matter so much when you want to move the teeth outward,—if you put so many bands upon them, you come to a point where those bands occupy space that you need. Now, it is very easy to limit the number of bands in a great many cases. If I had a case in which I wished to move the four incisors inward, instead of putting four bands upon them, I would put two. In other words, I would put a band upon each of the centrals and unite them, after which I would attach a bar to these bands which would extend over and rest upon the laterals, and that would serve to draw them all in. In that way I should have but one thickness of metal between each central and lateral and none between the laterals and cuspids.

So, also, in the matter of molars. When you have a molar which you wish to band, and another adjoining, it is a very difficult matter, as Dr. Jackson has said, to press those teeth apart on two sides, so you can have room for a double band. You

certainly need a double band to prevent tipping, but a very simple way is to make a small band and put it on. Then make this in the form of a horseshoe, fitting this tooth, and attaching right here. I am afraid this diagram is a little misleading, but if you understand it you will see that we have but a single thickness between the teeth, instead of having two. Dr. Jackson spoke of swaging a cap to cover the teeth and come down as far toward the gingival margin as possible. That is a most excellent way where we want to use deciduous teeth as our anchorages, but in the case of permanent teeth very frequently the proper occlusion of the opposite teeth will be prevented by it. For that reason, in a majority of cases, I prefer a band arranged so as not to interfere with the interdental spaces more than is necessary.

For the beautiful appliances shown by Dr. Case, and the artistic construction of them, as shown in the models, I have the greatest admiration. Dr. Case deserves all the credit we can possibly give him for this work that he has presented.

DR. CASE: Mr. President and gentlemen of the American Dental Association, I have met with about the reception that I expected at the hands of Dr. Ottolengui. Nor am I surprised at the errors he has fallen into where he attempts to disprove the scientific correctness of my methods of applying force; but I must say that I am greatly surprised when Dr. Guilford follows in the same vein, and insists upon certain things which, if true, would destroy some of the well-established elementary laws of physics. As I am led to believe that I shall be allowed but little time to close the discussion, I shall not attempt to answer, at this time, much that I would like to, but will confine my remarks to this particular feature in the application of force. Before doing so, however, permit me to thank gentlemen who have spoken in my favor. My paper was written with the hope that I might aid in establishing a more systematic and scientific practice in this department of dentistry, and that we might be able to teach our students the fundamental principles of the application of force, upon which the whole structure of orthodontia depends. In this way we would in time place this branch upon a far higher and more scientific basis.

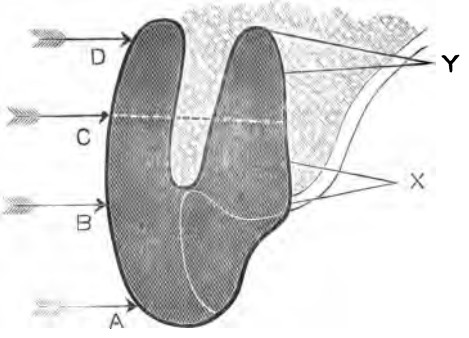
Now, in regard to the question in controversy relative to applying force. It has been said of Fig. 9 that force applied at any

point upon the upright bar extending above the border of the gum is exactly equivalent to applying the force at a point upon the tooth where this bar comes in contact with the tooth. And Dr. Guilford has told you that when I solder a tube upon an anchorage extension above the margin of the gum I exert no other influence toward preventing the molar from tipping than I would if the tube was soldered upon the band itself. I claim that if the upright bar or extension is *rigid* and immovably attached to the crown, force applied to it above the crown is exactly equivalent to applying that same force to the root at a point that is on *the line of direction of that force.*

I think I can make this plain with a drawing. (See Fig. 19.)

FIG. 9.

FIG. 19.



I will make the upright extension about equal in size to the root of the tooth; and now, if you please, let us suppose that the tooth and the extension are one solid piece of iron, with that part which represents the root imbedded in a yielding substance like the alveolar process. Now, if I apply force in the direction of the arrow at A,—as I have explained in my paper,—that force is received upon the process principally at X, and in proportion to the resistance along this area it acts as a fulcrum, with a tendency to carry the apical end of the root forward, and consequently with a far greater tendency to tip the crown from an upright position than if the force was applied at B, or as far up on the crown as would be possible without the extension, because the force would be distributed over a greater area along the posterior wall of the alveolus. But with our extension, which I have here drawn

large, and suppose the whole to be one solid piece of iron, in order to impress you with the meaning of *absolute rigidity;* if now we apply our force at C, or, in other words, at a point whose line of direction upon the root would be equally distant from X and Y, would not the entire root be carried backward in an upright position, provided this area of resistance is uniform? Again, if we applied the force at D, would not the area Y receive the principal portion of the force, with lessened movement of the crown? And, further, if we should make our extension longer, so as to apply our force *above* the end of the root, would not the area Y come to act as a fulcrum in proportion to its resistance, with a tendency to tip the crown forward? I think any one with a little thought must see that, and, if not, a simple mechanical contrivance would soon verify it.

Therefore, if an upright rigid bar is attached immovably to the crown of a tooth by means of a band, and force is applied here (indicating C, Fig. 19), would it not be exactly the same as it would be if a hole were bored through the process at that point and you pushed against the root itself?

DR. GUILFORD: No.

DR. CASE: Well, it would, and you will find it so. All you have to do is to make some little simple appliance that is rigid in itself to prove it.

DR. RICH: Your theory is that the band must be rigid with the tooth itself, so that it becomes, for the purposes of movement, a part of it?

DR. CASE: Certainly, and if the upright bar could be extended as high as the end of the root, and made rigid, my theory would be just as true. At whatever point on the bar you apply the force it would be the same as it would be if you applied the force directly to the root at that point.

DR. RICH: That is a correct mechanical principle. The force will move in a direct line, of course, if the thing is stiff. It must be rigid to do that.

DR. GUILFORD: As I understand you, you claim that the power applied there has greater efficiency in the moving of the tooth than if it were applied here (indicating)?

DR. CASE: No, not that. It would not exert any greater power.

DR. GUILFORD: Why do you extend it up then?

DR. CASE: My object in the application of an extension of this kind, as I have repeatedly said, is to prevent the tipping of the crown by distributing the force of movement over a greater area.

DR. GUILFORD: That you do by virtue of the band, not by virtue of this (indicating the extension), and this is something attached to the band to help you to accomplish it.

DR. CASE: Well, it would be different, permitting the exertion of a different quality and direction of power.

DR. GUILFORD: Why not apply it here (indicating)? Would not that have the opposite effect? Would you not, if you applied that force here (indicating), have the same effect as if applied to this point here (indicating)?

DR. RICH: And that proves the other principle to be correct.

DR. GUILFORD: Not at all.

DR. RICH: It shows that force is always in a direct line.

DR. GUILFORD: If it was in a direct line it would pull back here.

DR. RICH: Force is always in a direct line.

DR. MOLYNEAUX: Mr. President, it seems to me that these gentlemen are all mixed up on a little point in physics. This is a movable body, and the power is attached to this lever. Dr. Case is wrong when he says it makes no difference how high up you extend this bar.

DR. CASE: Do not misquote me, please.

DR. MOLYNEAUX: You said you could extend that bar as high as you pleased, that the movement will always be in the direction of the power.

DR. CASE: At the point where the power is applied, yes, if the bar is rigid; but, as I have stated in my paper and in the discussion, some part of the area that received the force might act as a fulcrum, followed by a movement of some other part of the tooth in the *opposite* direction.

DR. MOLYNEAUX: This tooth is movable, as I understand, and there is a theoretical center between the alveolus and the point of the root. If you apply power to this lever, directed at right angles to the long diameter of the body you are moving, the force will travel from the end of the bar to its attached point.

The power will then pass upward and intersect the line of force upon the opposite side of the tooth, which would bring that power a little higher up on the root than if the power was applied directly upon the band. If the power is exerted upon the end of a bar extending beyond the neck of the tooth, the bar being attached to a band which is rigid upon the tooth, then the force exerted will be felt at a point on the root of the tooth directly opposite the point where the power is applied, provided it does not pass the theoretical center between the margin of the alveolus and the point of the root. (Applause.) If that bar extends up on the root of this tooth past this theoretical center, the force will operate in the opposite direction, and it will draw the point of the tooth outward instead of inward, as is desired in this case.

SECTION IV.

HISTOLOGY AND MICROSCOPY.

REPORT BY I. P. WILSON, SECRETARY OF THE SECTION.

THIS Section on Histology and Microscopy has sustained a great loss during the past year.

Dr. Frank Abbott, who has been Chairman of the Section every year, with two exceptions, since the establishment of this branch of study in this Association, has passed away.

On examining the Transactions of this Association, I find that the first researches ever conducted in this country, to determine the etiology and progress of the carious process in human teeth, were conducted by Dr. Abbott in 1878, and I learn also from the records that nearly every pathological condition found in these important organs has been microscopically studied by him, and the results obtained have been from time to time reported to this Association. Only twice since the establishment of this Section has he failed to contribute a valuable paper.

Dr. Abbott has kept this Section alive. In 1894, at Old Point Comfort, he was the only member of the Section present. But he realized, as we all must, that the wealth of this comparatively new field of research has not been exhausted, and has yet in store for us rich fruitage.

Only a short time before his death he wrote me an earnest letter regarding the work of this Section, and expressed a desire that we secure, if possible, a greater interest in this important line of investigation.

The Transactions of the American Dental Association for a score of years are richer because of his untiring researches.

If the pages of our dental journals are to be regarded as an index

to the histological and microscopical investigations of the past year, but few have been engaged in this line of study. It is with pleasure, however, that we call attention to a paper read before the New York Odontological Society last January, by Dr. J. Leon Williams, London, Eng., it being "A Contribution to the Study of Pathology of Enamel."

This paper, illustrated by about one hundred photo-micrographs, was published in the *Dental Cosmos* of March, April, and May of the present year, and should be read and carefully studied by every member of the dental profession.

This paper certainly marks an epoch in the development of dentistry. While it is true that Dr. Black had in some sense foreshadowed what Dr. Williams has brought out regarding the influence of films formed by micro-organisms, it has remained for Dr. Williams to demonstrate it. This clear demonstration by Dr. Williams fully merits the credit of discovery. His study of the teeth, with reference to their liability to caries, is also very important, especially the studies of the condition of the enamel.

One paper only has been secured for this Section; it is by I. Norman Broomell, D.D.S., Philadelphia, entitled "Macroscopic Tooth-Development," illustrated with lantern slides from original dissections.

SECTION IV.—Continued.

Macroscopic Tooth-Development.

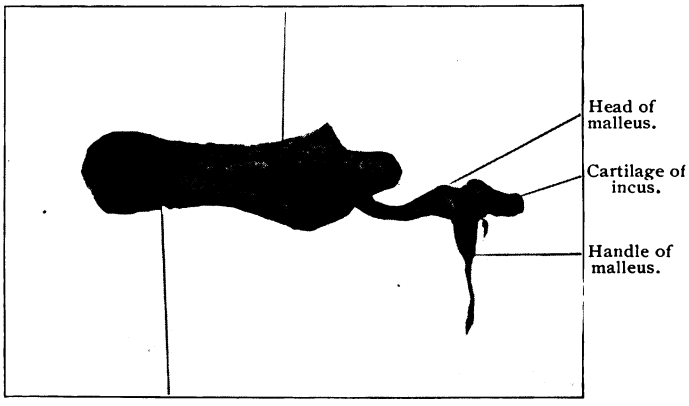
PAPER BY I. NORMAN BROOMELL, D.D.S., OF THE SECTION.

BEFORE taking up the subject of tooth-development it will be eminently proper briefly to describe those parts directly concerned in the process. At a very early period of fetal life we find preparations are being made for the development of the maxillary bones. That these are about the first bones to be called into functional activity accounts in a measure for their very early development. The osteoblastic activity in the intercellular substance destined to become the inferior maxilla begins about the middle of the second month of fetal life, while at a somewhat later period a similar action takes place in the region of the superior maxilla. It will be unnecessary to give a detailed description of the development of the body of these bones, but to that portion which gives lodgment to the tooth-germs, and which in a measure is controlled by their presence, some attention must be given, and for this purpose the mandible will be used.

Fig. 1 represents the lingual face of the lower jaw after removal from a three months' fetus. Attached to it is the remaining portion of Meckel's cartilage, which by this time is much wasted away. It will be recalled that this cartilaginous band appears in the mandibular processes before the beginning of the second fetal month, being formed in two distinct halves, the free ends of which finally unite at the median line, forming a continuous support or framework, about which ossification takes place. At a corresponding period, and in a similar manner, two like processes are thrown out for the superior maxillæ, but, unlike Meckel's cartilage, these do not unite at the median line, but stop short of this, the space thus

resulting being provided for by two additional processes which shoot down from the region of the forehead and provide for the development of the intermaxiilary bones. About the middle of the second month a center of ossification appears in the neighborhood of the future mental foramen, quickly followed by others at the symphysis and at the angle. These secondary centers soon unite with the primary one, and by the end of the second fetal month the osseous contour of the primitive jaw is established. While ossification takes place in the membrane surrounding Meckel's cartilage, the cartilage itself does not appear to be directly concerned in the process, and by the sixth or seventh fetal month

FIG. 1.
That part of cartilage not yet ossified.

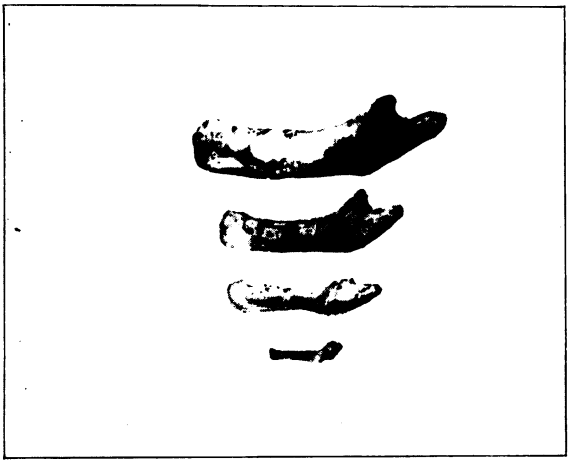


the mandibular portion completely disappears, while that portion near the tympanum is ossified into the malleus. That portion of the bone which forms above Meckel's cartilage and the inferior dental nerve is that which gives support to the tooth-germs, which are already preparing to occupy its concavity. This cartilage is not confined to the human species, but is the common heritage of reptiles, rodents, birds, and fishes, in all of which it gives support to the developing lower jaw.

Fig. 2 represents the evolution of the mandible from the middle of the third month up to the time of birth. It will be observed that during this interval there is a gradual increase in the size of the bone, but little alteration in its contour. By a constant

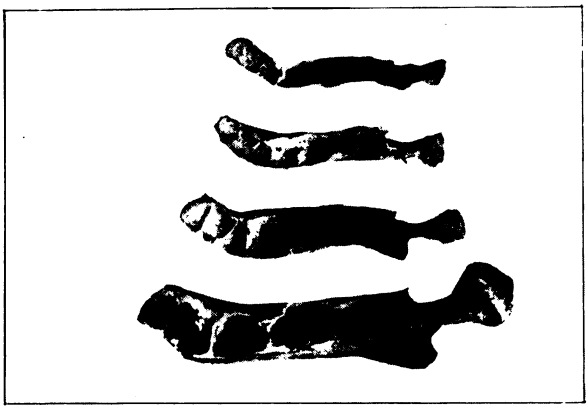
and gradual osseous deposit about the distal extremity of the bone its length is increased to accommodate the additional teeth as they appear. While the external form of the bone shows but slight

FIG. 2.



Two-thirds actual size.

FIG. 3.



variation during this period, the internal structure, or that wherein the tooth-germs lie, is undergoing a complete transformation.

Fig. 3 is illustrative of these changes, beginning with a simple

groove or gutter in which the tooth-follicles hang, the follicles exerting a controlling influence over its form. Next comes the appearance of the septa between the anterior follicles, which at this period are irregularly placed in the arch, followed in a few weeks by a well-defined partition between the cuspids and molars, until finally at birth each follicle is inclosed in its individual crypt, with the single exception of the second molar, in which the distal septum, or that which is to separate it from the first permanent molar, has not yet made its appearance. As the tooth-sacs increase in size, by the development of the teeth within, they become more perfectly inclosed in the bony vaults, the sides of the alveolar walls arching over and almost completely inclosing the developing teeth.

FIG. 4.

Fig. 4 shows the lower jaw of a seven-months-old child, embodying the condition above referred to. No sooner have the crypts grown to this extent than the resorptive action produced by, or provided for, the advancing crowns speedily results in their downfall, to be again built up with the evolution of the permanent teeth. About the first visible sign of preparation for the development of the teeth, other than that made apparent by dissection, may be observed as early as the beginning of the third fetal month, when, upon opening the cavity of the mouth and looking upon the palate, a well-defined infolding of the epithelial eminence will be seen. In Fig. 5 this condition is shown by a dissection through the oral cavity of a four months' fetus, the outer fold being that of

the cheeks and lips, while within are the hard palate and the primitive alveolar ridge. The mouth at this period has passed the rudimentary state, the transverse plates which contribute to the formation of the hard palate having approached each other until the oral

FIG. 5.

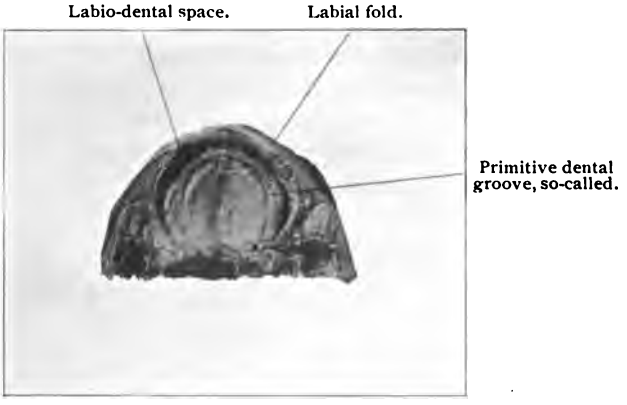
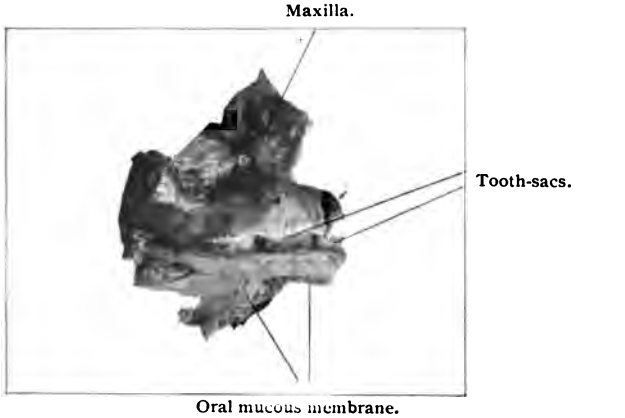


FIG. 6.



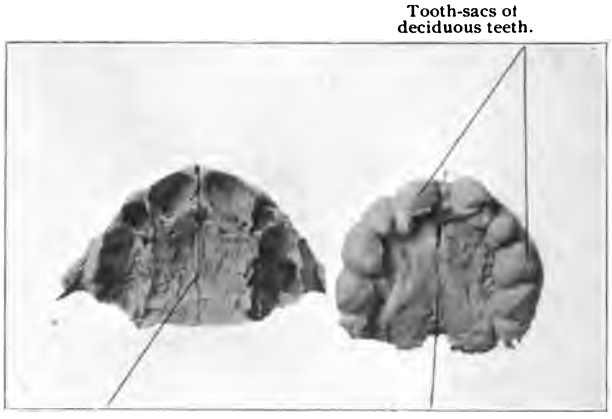
and nasal cavities, heretofore existing as a single buccal cavity, have become separate and distinct.

The infolding of the oral epithelium as outlined on the summit of the primitive alveolar ridge—the primitive dental furrow, so-called—marks the position of the tooth-band, from which are given

off the incipient tooth-bulbs. For the purpose of further investigation a dissection of these parts was made and the superior maxillary bones removed, after which they were divested of their fibrous covering, including the periosteum. That portion which overlies the palatal processes was readily lifted in one sheet, while that upon the facial surface was separated at the median line and stripped independent of the other, as shown in Fig. 6.

The removal of these tissues is readily accomplished until the margins of the partly formed alveoli are reached. Here the periosteum dips down into the various crypts and serves as a lining membrane for them, and probably contributes fibers to the outer layer of the follicular wall.

FIG. 7.



After advancing thus far the detached tissues may be grasped, and by careful manipulation the tooth-follicles containing the formative organs removed from their respective vaults and turned over for examination.

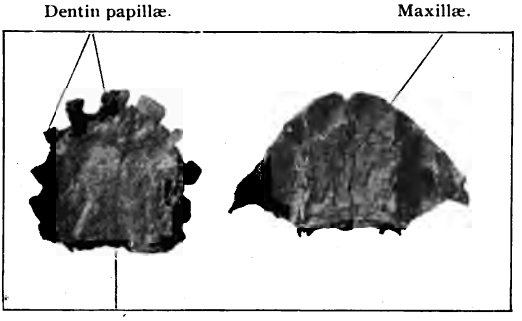
Fig. 7 shows the result of such a dissection. On the left the palatal plates and alveolar walls of the divested bones may be observed; on the right the fibrous covering which has been turned back from the bones, and to which are firmly attached the ten tooth-follicles for the temporary teeth. If this dissection be made without the precaution of lifting the periosteum, the follicles would not cling to the oral membrane with sufficient tenacity to permit of their ready removal.

It may be of some interest to note that at this early period the position of the follicle containing the germs for the lateral incisors is that which the tooth is forced to occupy up to and frequently beyond the eruptive period, being crowded within the tooth-line by the central and cuspid, in consequence of which the crypt is thrown well into the palatal plates.

Before entering upon a description of the tooth-follicles as regards their structure and mode of development, let us investigate their contents.

Fig. 8 represents the sacs broken down, exposing to view the dentin papillæ, or those structures destined to become the tooth-pulps. The position which these occupy in the illustration is exactly the reverse from that which they assume when in posi-

FIG. 8.



Oral mucous membrane, turned completely over.

tion in the follicle, being thus reversed that a better idea of their shape may be observed. Prior to the twelfth or thirteenth week of fetal life this incipient bulb or papilla is without definite form, but by the latter period each papilla begins to assume the contour of the future tooth, as faintly outlined in the illustration, those of the incisors presenting the angular form of the future cutting-edge, the cuspids that of the simple cone, while the coronal extremities of the molars are represented by outlines corresponding to the future cusps and marginal ridges. Beside the dentin papilla, which is the formative organ for the dentin, there is contained within the follicular wall the organ which later on is productive of the enamel, but which up to this time has been actively engaged in molding the tooth-form as outlined by the papilla.

To return to the tooth-follicle, the dissection in this instance being upon the lower jaw of a four months' fetus:

Fig. 9 shows the mandible removed and the dissection carried to the point at which the follicles may be lifted from their bony encasements, this being accomplished by an incision along the base of the bone, followed by a stripping of the membrane, first from the facial and then from the lingual side of the bone. When these two flaps reach the margins of the crypts they are firmly grasped and the follicles removed from their sockets, as illustrated in Fig. 10.

FIG. 9.

Oral mucous membrane and periosteum dissected from mandible.

Enlarged one-third. Attachment of follicle to oral membrane.

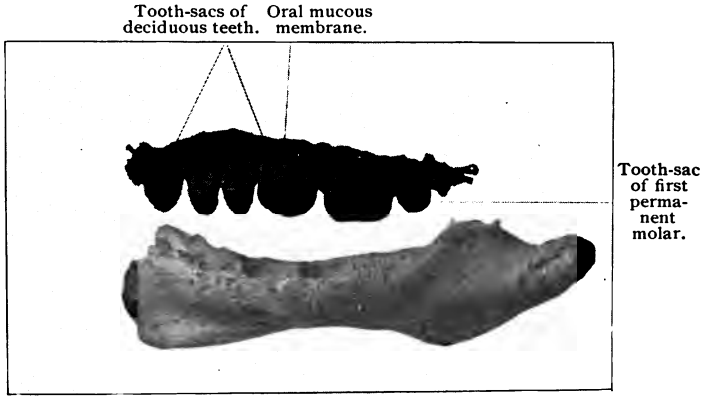
The term "follicle" is only one of a number applied to these parts, "dental sacculus," "tooth-sac," and other appellations being employed with equal significance. By some writers it is customary to apply the term "follicle" up to the period of complete closure, the term sac or sacculus being employed after that time. There appears, however, to be little foundation for such a distinction, the terms being synonymous. Again, the follicle is frequently referred to as meaning the sac and its contents, but this usage is a misapplication of the term. There appears to be no well-founded reason why the follicular wall or sac should not be referred to as such, regardless of the formative organs within.

As to the development of the tooth-follicle, it appears to be a generally accepted theory that at a very early period there are

developed from the base of the papilla cells, which differentiating, form the walls of the follicle. By this growth of cells the papilla is first surrounded, and this step is soon to be followed by an extension of the cellular structure in the direction of the oral mucous membrane, to the deep layer of which the cells become firmly attached, and in so doing inclose the enamel-organ, which hangs like a hood over the extremities of the papilla.

The tissue thus formed from the base of the dentin-germ is continuous with and similar in its origin to the pulp-substance. The primitive tooth-germ, during the formation of the follicular wall,

FIG. 10.



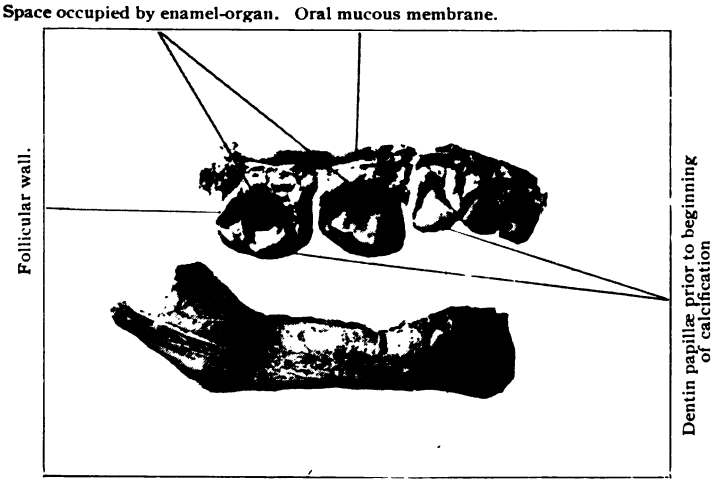
Enlarged one-third.

is found swinging in a membranous pocket, being supported by the epithelial band, which in turn is attached to the oral epithelium; but as the walls increase and completely inclose the germs, which is accomplished about the fourth fetal month, the epithelial band is broken, and the second or saccular stage of tooth-development is reached. The walls of the follicles are made up of two layers. In the illustration the sac for the second molar has been partly divested of its outer layer, which is dense and firm, and finally becomes the dental periosteum; the inner layer being thin, frail, and, in the recent state, somewhat transparent; at an advanced period it assists in the formation of the cementum.

At the beginning of the saccular stage of development the form of the future tooth-crown is well outlined by the dentin papilla,

which in Fig. 11 is brought into view by a dissection of the walls of the follicles without breaking the attachment existing between the two. As in the case of the follicle, much confusion of terms in regard to this structure exists, the "dentin-bulb," the "pulp," "dentin-germ," the "papilla" being used *ad libitum*, without apparent regard for the structural changes which are continuously affecting the organ. It would seem proper to simplify this conglomeration of terms by a classification appropriate to the various stages of development. For my purpose the term "dentin papilla" will be employed when referring to this organic structure up to the

FIG. 11.


Space occupied by enamel-organ.
Oral mucous membrane.
Follicular wall.
Dentin papillæ prior to beginning of calcification

time of beginning of calcification, subsequent to which the term "pulp" will be used. As previously stated, the enamel-organ up to this period has been principally devoting its energies to the molding of the tooth-form, and it is not until this model as represented in the papilla is complete that the process of calcification begins.

About the fourth fetal month preparations for the calcification of the teeth are begun by the development of the odontoblastic cells for the dentin, closely followed by the ameloblastic cells for the enamel, the former establishing themselves upon the peripheral extremities of the dentin papilla, while the latter make their ap-

pearance in the enamel-organ, which surrounds and completely envelops the papilla.

Fig. 12 is prepared from a dissection made in a manner similar to that shown in Fig. 8, but at a period about one month later,

FIG. 12.

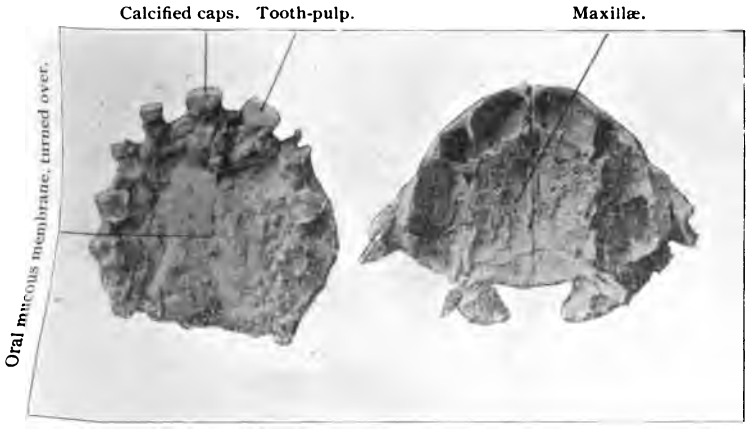
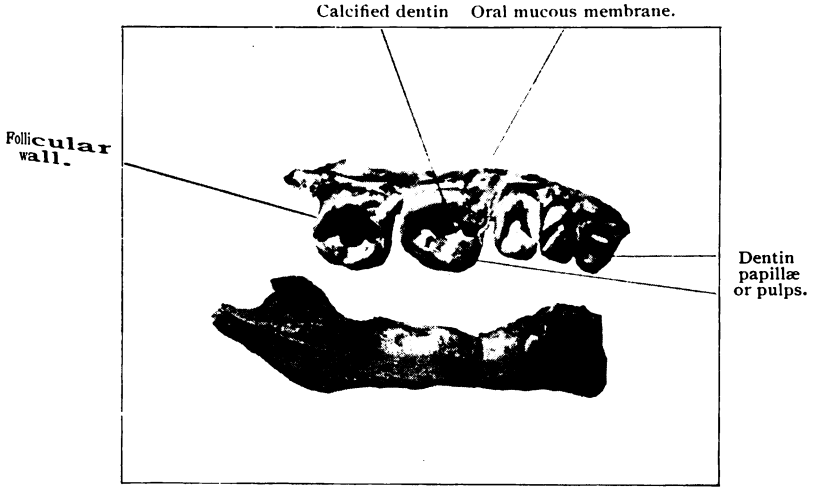


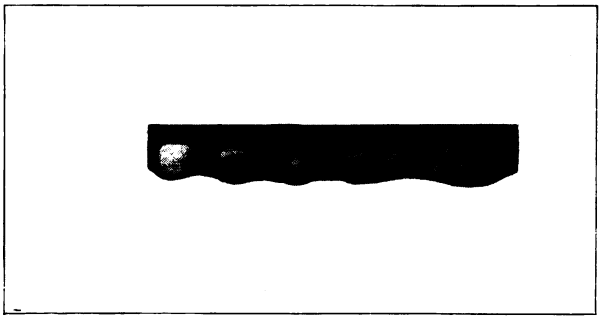
FIG. 13.



being from the superior maxilla of a five months' fetus. The dissection shows the extent of calcification at this period, which process also defines the position of the odontoblastic cells upon the

surface of the papilla. In the incisors (one of which was lost in the preparation of the specimen) the dentin is seen capping the cutting-edges. The cuspids in this subject have not yet begun to calcify, although it is not unusual to find the cusp of this tooth receiving its lime-salts at this early period. In the molars the summits of the various cusps, as well as a portion of the various ridges descending therefrom, are undergoing the change produced by the impregnation of the lime-salts. It is probable that these delicate caps at this period are composed of dentin alone, the calcoglobulin which precedes the enamel-calcification being somewhat later in forming. From this time forward the pulp undergoes

FIG. 14.



a gradual transformation as to size and form, and there is likewise a change in its cellular construction in those parts adjacent to the calcific action. While the outline of the pulp is gradually changing, its form is permanently recorded upon the periphery of the dentin cap, which when once formed is immutable, all additions to its bulk taking place from within. In the incisors the three primitive lobes or cusps are visible, each indicating a separate center of calcification.

Fig. 13 illustrates the result of a dissection upon the lower jaw of the same subject, disclosing practically the same conditions, with the exception of the sac containing the developing cuspids, which was found with a slightly calcified cap of dentin. This variation between the upper and lower jaws corresponds to that observed in nearly every dissection, the calcification of the lower teeth being slightly in advance of the upper.

In Fig. 14 the tooth-pulps with their primitive cappings of dentin have been removed from their follicles, presenting a better opportunity of studying the relations existing between these two parts. By the conversion of the coronal extremities of the dentin papilla into odontoblasts, and their active calcification, some posi-

FIG. 15.

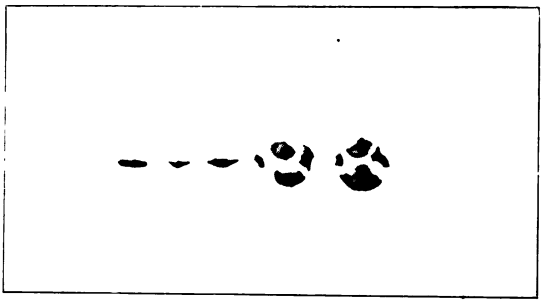
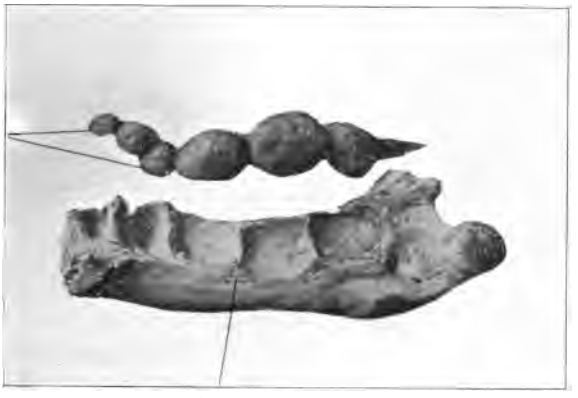


FIG. 16.



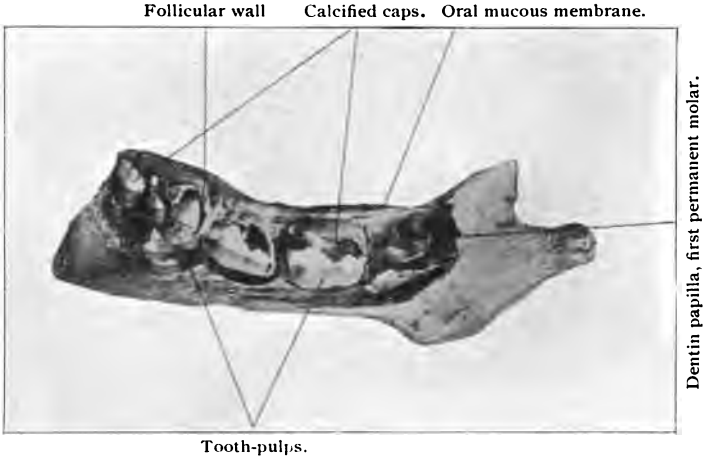
Lingual surface of mandible.

tive union between the two structures might be expected. On the contrary, the dentin caps are readily removed, leaving the pulp beneath without the slightest rupture.

Fig. 15 shows the dentin caps thus dislodged, those for the incisors and cuspids, which begin to calcify from three centers, having coalesced, while those for the molars are separate and distinct, union not yet having taken place.

The next dissection was one made upon the mandible of a six months' fetus. Fig. 16 shows the tooth-follicles removed from the partially formed bony crypts in which they have been incased. At an early period of fetal life, and at a time prior to the completion of the tooth-follicles, there is deposited beneath the tooth-germs a thin layer of bone, which at once begins to assume the form of the partially developed follicular wall. As the growth of the follicle proceeds there is a corresponding increase in the osseous deposit, the alveolar walls extending about and accommodating themselves to the membranous sac. Thus we find in this portion of the maxil-

FIG. 17.



lary bones a feature peculiar to itself,—that of a continuous transformation from its earliest inception to the adult period, first developing about the temporary tooth-sacs and completely incasing them, which is speedily followed by complete resorption of the walls, again to be followed by a rebuilding during the evolution of the permanent teeth, to be again swept away with the loss of these organs.

Fig. 17 displays the opposite side of the same jaw, with its outer or facial plate removed, together with the intervening septa. The follicles are opened and the extent of calcification at this period (six months) made apparent. The pulp and calcified caps are approximately as found when dissected, save a slight settling of

all the parts. The incisors have calcified to about one-third their full coronal length, the unicuspid contour of the cuspid has been established, as shown by the deposit of lime-salts upon the summit and the upbuilding of the mesial and distal cutting-edges. The first molar has its occlusal surface about completed, and while the cusps of the second molar are nearing completion there is a lack of union in the central and distal fossæ. Immediately posterior

FIG. 18.

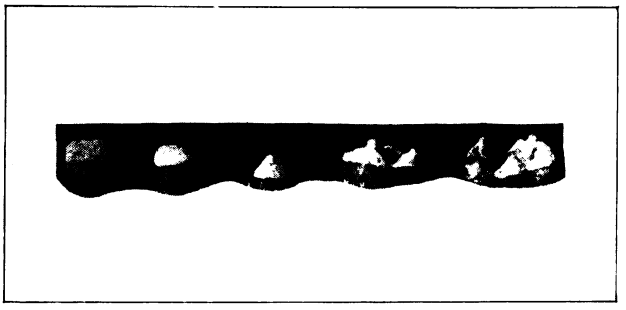
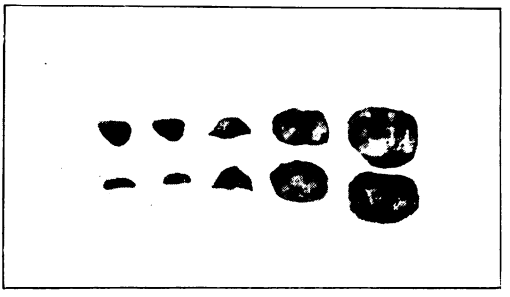


FIG. 19.



to the second temporary molar the sac which contained the formative organs for the first permanent molar has been opened, exposing to view the dentin papilla, which at this early period has assumed the form of the future tooth-crown, and calcification is about to begin.

Fig. 18 illustrates the pulps and calcified caps removed from their respective follicles. As calcification proceeds it will be observed that the angularity which originally accompanied the calci-

fying caps of the molars is gradually disappearing, also the tri-tuberculate stage of the incisors and cuspids, as represented upon their cutting-edges, this change being brought about by the enamel deposit.

FIG. 20.

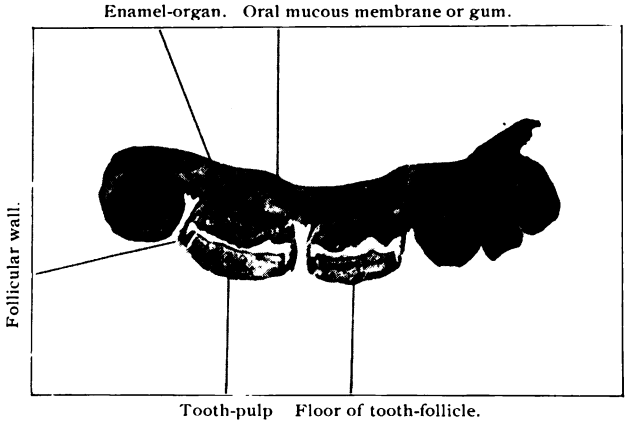


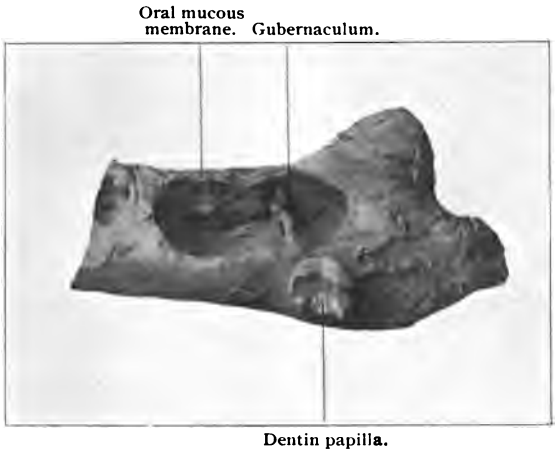
FIG. 21.

Fig. 19 shows the calcified caps removed from the pulp and so arranged that both their external and internal anatomy may be studied. Prior to this period there has been but little alteration in the form of the dentin pulp, only a gradual decrease in its size being noted; but now we find it being divested of many of its angles, particularly those which originally served as a basal form

for the coronal extremities of the future tooth. With the disappearance of these the concavity within the cap is slowly assuming the form of the future pulp-chamber.

That a better understanding of the saccular stage of tooth-development might be had, a transverse incision was made through the molar follicles, as shown in Fig. 20. In this the attachment of the follicular walls to the deep epithelial layer is visible, while within the walls are the enamel-organ, the calcified dentin, and the tooth-pulp. As previously stated, the enamel-organ is seen suspended above and forming a hood-like investment to the calcifying structure. This organ not only overhangs the occluding surface

FIG. 22.



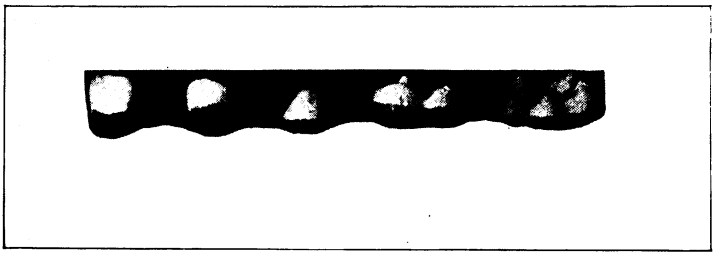
of the tooth, but completely envelops the sides of the calcified cap and dentin pulp. Previous to the beginning of calcification the enamel-organ is in close proximity to the dentin papilla, the original form of the latter being here represented by the calcified dentin.

We have now arrived at that period of fetal existence when it is possible to study the macroscopic development of the first permanent molar. Fig. 21 represents a section of the lower jaw of a six months' fetus, and displays the sacs containing the developing temporary molars, as well as that of the first permanent molar. In most respects the evolution of this tooth, as well as that of all the permanent teeth, is similar to that of the temporary, having its

origin from the primitive tooth-band, which is continued horizontally backward as the jaw increases in length, and between the second and third fetal month the enamel-organ for the tooth is given off, and thereafter the developmental process is identical with that of the temporary teeth.

There is one structure, however, intimately connected with the development of the permanent teeth, but not found in connection with the temporary teeth, and that is the gubernaculum or leading cord. Fig. 22 represents another section of a six months' fetal mandible, with the dentin papilla for the first permanent molar turned out from the follicle after being rolled from its bony incasement. Attached to the apex of the sac (which has been turned back), and leading from it to the epithelium of the jaw, is the

FIG. 23.

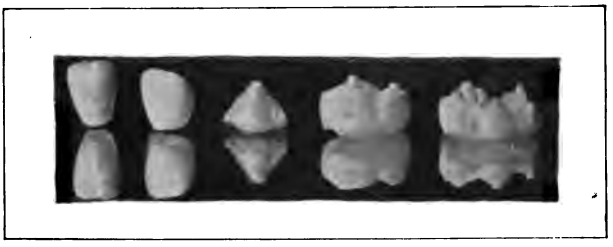


gubernaculum. This fibrous structure was at one time thought to be directly concerned in the development of the tooth. Although this is denied at the present time, little is said in regard to its function, but it undoubtedly serves the purpose of directing the tooth to that position which it should occupy in the jaw, and where the least resistance to its eruption is formed by the foramen which the cord has established. Each of the permanent teeth is provided with a similar cord, an illustration and further description of which will follow later.

We will now return to the temporary teeth. Fig. 23 shows the result of a dissection at the seventh fetal month, illustrating the extent of calcification at that period. Fully one-half of the incisor, cuspid, and first molar crowns is formed, while the second molar has its occlusal surface about completed. We have now arrived at a period when the subject under consideration natu-

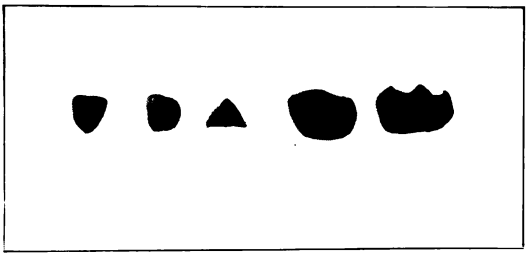
rally becomes of deeper interest. I refer to that time when the being changes from a complex dependent condition to one of self-providing independence. Previous to the time of birth the teeth appear to be but little disturbed by certain morbid conditions which might be present in the parent, and from their earliest inception up to this period their development proceeds with but little interruption and with much regularity. From the numerous dissections made in preparation for this paper, I found the teeth at birth about as represented in Fig. 24, the central incisors

FIG. 24.



Reflected picture.

FIG. 25.



having calcified to the cervical line, the lateral incisors to a point corresponding to the summit of the palato-cervical ridge, the cuspids having advanced somewhat beyond the angles of the crown, while the molars have their crowns calcified to about one-half their completed length.* With all this progress as represented in the external contour of the tooth-crowns, the internal form appears to be extremely slow in assuming the shape of the future pulp-chamber, as shown in Fig. 25.

* With slight variation this corresponds to the investigations made some years ago by Professor Peirce.

Fig. 26 is another illustration of the upper teeth at birth, and depicts to better advantage the concavity of the pulp.

From the beginning of the saccular stage of development up to the time of birth, there is but little increase in the diameter of the tooth-sac, but there occurs a gradual increase in its length. Fig. 27 shows the mandible from a child one week old, with a greater

FIG. 26.

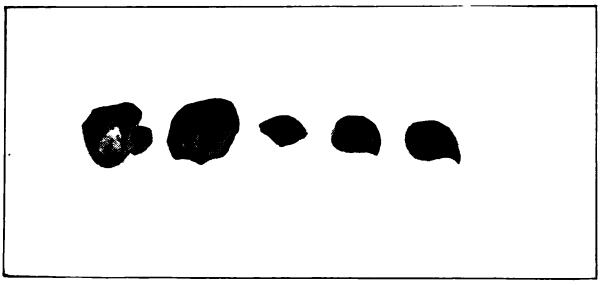
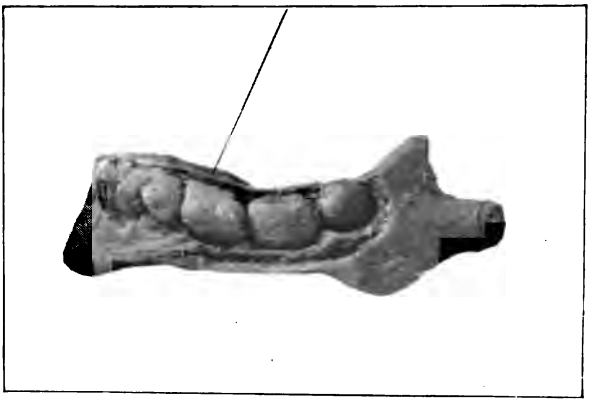


FIG. 27.
Oral mucous membrane.



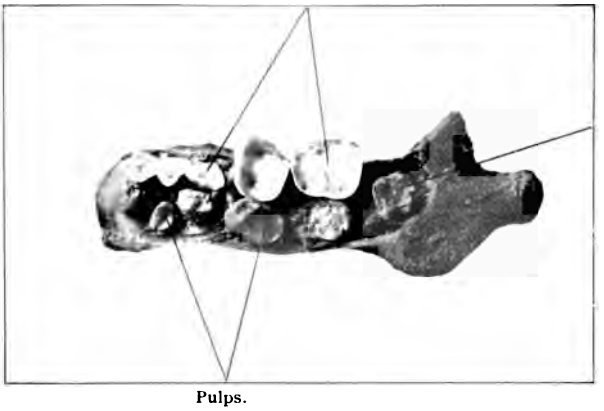
part of the external or facial surface of the bone removed, exposing not only the sacs containing the developing temporary teeth, but also of that of the first permanent molar. The relation of the sacs to the inferior dental canal is apparent, as well as the firm attachment of the follicular walls to the oral membrane.

In Fig. 28 the sacs have been dissected and the pulps removed from the calcified caps, presenting a further illustration of the

amount of the dentin deposit at this age. In the first permanent molar the summits of the various cusps are showing the effect of the calcific action.

To further illustrate the size and form of the pulp, as compared with the calcified cap at this age, a transverse incision was made through the left superior maxilla, at a point corresponding with the base of the pulp, as shown in Fig. 29. The calcified parts were allowed to remain in position and resting against the remaining portion of the enamel-organ, while the pulps were dislodged and are seen resting upon the incised surface. The dentin papilla for the first permanent molar is seen hanging by its gubernaculum.

FIG. 28.
Calcified caps.



It also may be noted that those parts of the pulp corresponding to the cusps and marginal ridges show a decided convergence of the surface toward the center.

Reference has been made to the formation of the follicular walls by a differentiation of cells which are given off from the base of the dentin papilla at an early period, and to the continuity of the two structures. Fig. 30 was prepared for the purpose of showing these intimate relations. The sides of the sacs were opened and turned back, the calcified tooth-caps, with pulps in position, were grasped and given several revolutions, thus twisting the remaining portion of the walls, the floor of which is seen as a continuous structure given off from the pulp and connecting it with the epithelium of the jaw.

Before taking up the development of the permanent teeth, I desire to call your attention to Fig. 31, and in so doing describe the methods by which the illustration was secured, which

FIG. 29.

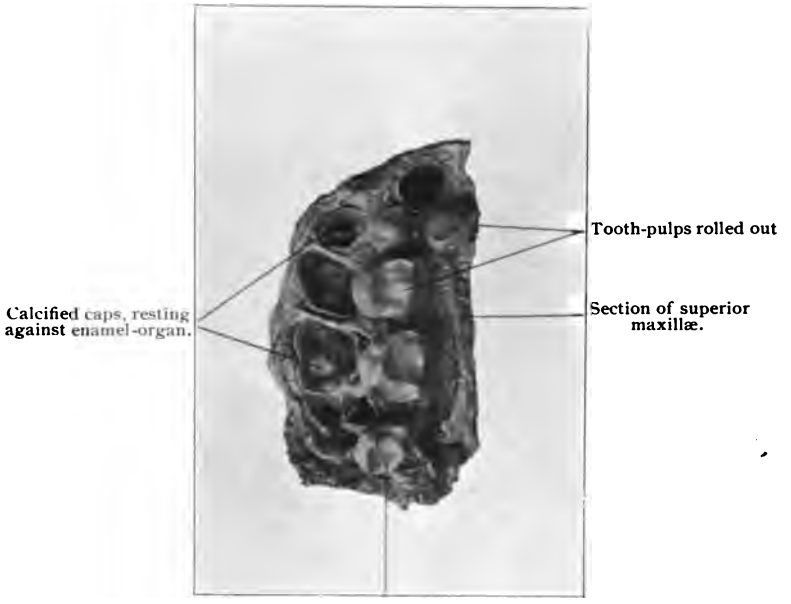
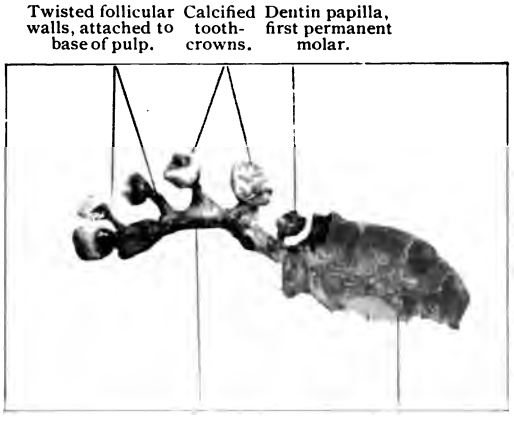


FIG. 30.


Twisted follicular walls, attached to base of pulp.
Calcified tooth-crowns.
Dentin papilla, first permanent molar.
Maxilla.

serves the double purpose of explaining the evolution of a molar crown and the dissolution of the pulpal structure, when in the recent state, upon exposure to the atmosphere. The subjects employed for the purpose ranged from the fourth fetal month to birth. In each subject the sac containing the developing second

FIG. 31.

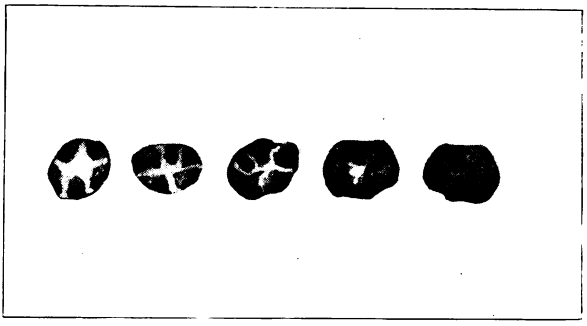


FIG. 32.

temporary molar was dissected and the pulps and calcified caps removed, immediately placed upon a glass slab, and set aside to note the changes in the organic structure. Within six hours a decided settling of the pulp-tissue was apparent, but no shrinkage of the periphery was noticeable, so that each tuberculate extremity

settled immediately beneath its dentin cap. Within twenty-four hours complete dissolution had taken place, leaving behind the calcified deposits, as shown in the illustration.

FIG. 33.
Foramina of gubernaculi.

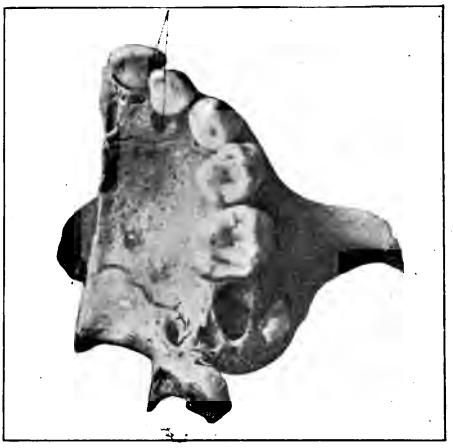
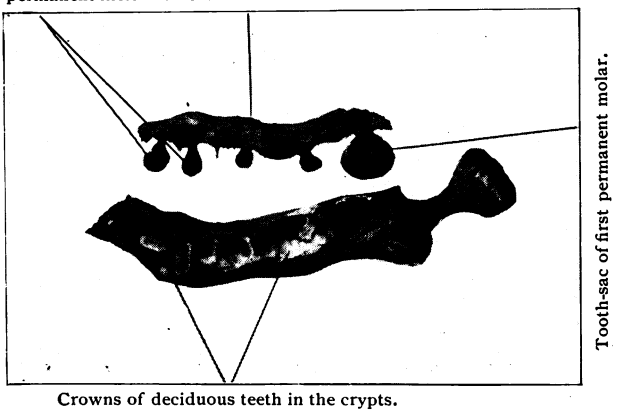


FIG. 34.


Tooth-sacs of permanent incisors.
Oral mucous membrane.
Tooth-sac of first permanent molar.
Crowns of deciduous teeth in the crypts.

By this time sufficient advance has been made in the development of the permanent teeth to permit a study of their relations with the temporary organs. The early preparations for the growth of these organs were for a long time a subject of much controversy, some writers advancing the theory that the follicles for the perma-

nent teeth were produced or given off from the sacs of the temporary teeth, others contending that the cord was derived from the remnants of the primitive cord immediately after its rupture. The now generally accepted theory is that the cord is given off from the primitive cord at a point in close proximity to its attachment to the temporary enamel-organ. Whatever theory be accepted, there can be no mistake about that part of the process which we are permitted to ocularly investigate. I shall therefore proceed to describe the position and contents of the permanent tooth-sacs at birth.

FIG. 35.

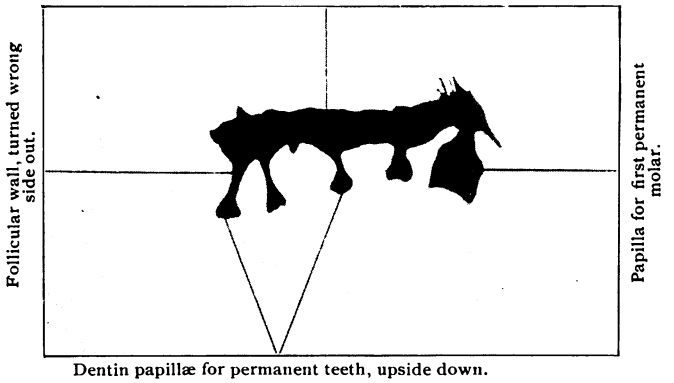

Oral mucous membrane.
Follicular wall, turned wrong side out.
Papilla for first permanent molar.
Dentin papillæ for permanent teeth, upside down.

Fig. 32 presents the result of a vertical dissection through the superior maxillary bones, the inner surface of the right superior maxilla being exposed to view. Many of the frail processes, particularly those entering into the construction of the nasal cavities, were lost during the preparation of the specimen, the whole purpose of the dissection being to show the sacs for the temporary and permanent incisors. Calcification in the temporary incisors has so far advanced that the contour of the tooth-crown is plainly outlined through the walls of the sac. Resting against the palatal concavity of the crown of the temporary incisor is the sac containing the formative organs for its permanent successor. This permanent sac does not long remain in such close proximity to the temporary tooth-crown, for as the latter advances toward the surface of the gum the former recedes and is soon inclosed in a separate crypt, which is provided with a foramen through which the

gubernaculum passes to join the gum. In Fig. 33 these foramina are seen immediately posterior to the incisor teeth. At birth these

FIG. 36.
Tooth-sacs of deciduous teeth.

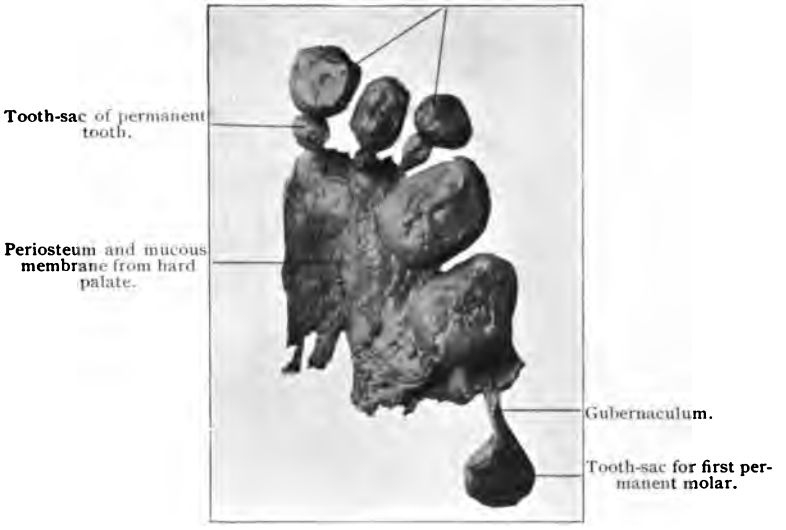
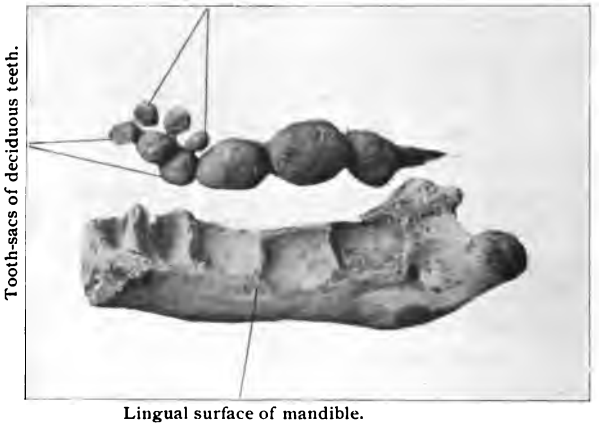

Tooth-sac of permanent tooth.
Periosteum and mucous membrane from hard palate.
Gubernaculum.
Tooth-sac for first permanent molar.

FIG. 37.
Tooth-sacs of permanent teeth.



foramina do not exist as such, the partially formed vaults containing the sacs for the permanent teeth appearing as an extension of the temporary crypts in a palatal direction; but as the temporary

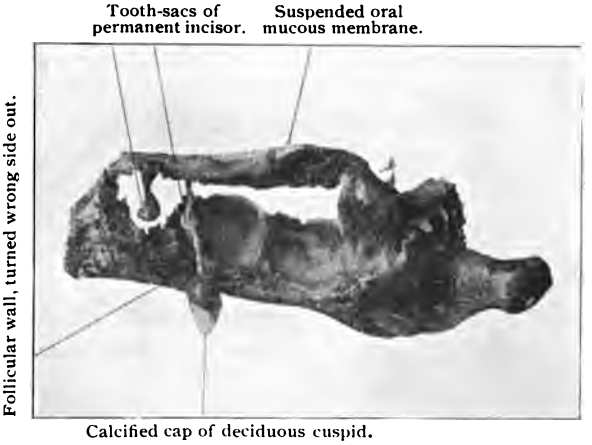
teeth advance and the permanent sacs recede the roof of the crypt is completed and the foramen established. This extension of the crypt is more clearly demonstrated in Fig. 34, which represents one side of the lower jaw at birth, with the partially calcified temporary teeth in position in the bone. Suspended above this is the gum, which has been dissected from the bone, having attached to its under surface the sacs for the permanent teeth. Those for the incisors are particularly well defined, and their place of lodgment in the bone readily seen. In the case of the cuspid, both the temporary tooth and the permanent tooth-sac are in position in the crypt. The cords which support the incisor sacs are lengthened out from the weight of the sacs, the gubernaculæ not assuming that thread-like form until the permanent sacs have further receded. Fig. 35 shows the result of a dissection upon these permanent tooth-follicles. The dentin papilla of the various teeth are seen in a reversed position, with the follicular walls attached to their bases. At this period the papilla for the incisors may be compared to the tail of a fish, being perfectly transparent over its free extremity, which feature is gradually lost as its thickened base is approached. The fish-tail appearance is further represented by the division of the free extremity into three distinct parts, each of which provides a separate point of calcification. The cuspid papilla is missing, and the bicuspids have advanced little beyond the form of the primitive bulb. The first permanent molar is shown, with the full diameter of the crown represented by the pulpal mass and the tips of the cusps calcified.

A further illustration of the progress of the development of the permanent teeth may be seen in Fig. 36, the dissection being made upon the left superior maxilla of a one-month-old child. The membrane has been lifted from the bone with the tooth-sacs attached to it. Immediately posterior to the sacs containing the crowns of the temporary incisors and cuspids are those for their corresponding successors, the papillæ of which have already assumed the tubercular outline of the future cutting-edges. While the permanent tooth-sacs are distinctively independent pouches, there appears, nevertheless, to be a well-established fibrous connection existing between the outer layers of their follicular walls. This fibrous union is gradually broken as the permanent sac recedes, and becomes incased in its own vault.

The next dissection, the results of which are made manifest in Fig. 37, was one made upon the lower jaw of the previous subject, and shows a like state of affairs. In this, however, the attachment of the permanent tooth-sacs in close proximity to the periphery of the temporary sacs is more clearly shown.

Fig. 38, the next dissection, was one made upon the lower jaw of a two-months-old child, the inner or lingual surface of the bone being removed, with the desire of finding the permanent tooth-sacs. The subject being in the recent state, the results were disappointing, but sufficient information was obtained to warrant the

FIG. 38.

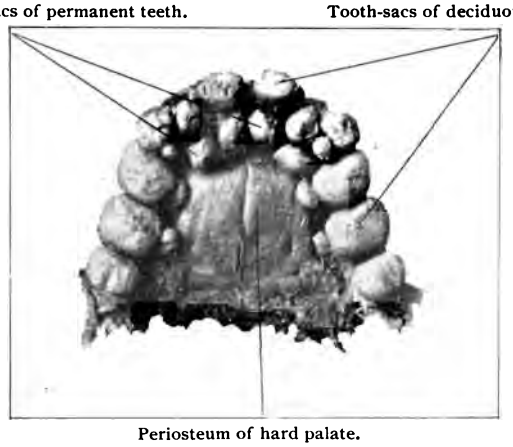

Tooth-sacs of permanent incisor.
Suspended oral mucous membrane.
Follicular wall, turned wrong side out.
Calcified cap of deciduous cuspid.

introduction of the illustration at this point. At its proper location the gubernaculum and follicular walls for the permanent cuspid may be seen given off from the deep epithelial layer, while a little below this point is the primitive sac containing the developing organs for this tooth, and below this is the partly calcified temporary tooth. The vascular supply to the follicular walls is shown in the first permanent molar follicle.

The last dissection made was upon the superior maxillæ of a three-months-old child, Fig. 39, with the result of bringing to view the temporary tooth-follicles and those of their corresponding successors. The permanent incisor sacs at this age are almost equal in size to those of their predecessors, and the dentin papillæ within possesses a mesio-distal diameter nearly equal to that of the calci-

fied temporary caps. The sacs containing the germs for the permanent cuspids and bicuspids are somewhat diminutive, but

FIG. 39.



the enamel-organ within is already molding the contour of the future crown.

DISCUSSION.

DR. MARSHALL: I want to express my appreciation of the exhibit upon which we have looked to-night. Any one who has ever attempted such dissections knows what an interminable amount of time and labor must have been put upon it. Dr. J. J. R. Patrick, at the time of his death, had been working for several years upon the same line of investigation, and at different times exhibited the results of his labors. I have just learned that Dr. Broomell has been working on this exhibit for over two years, and it seems to me, in view of these facts, that he is entitled to the thanks of this Association for what he has done for us this evening. Therefore, I move a vote of thanks.

The motion was unanimously carried.

DR. PEIRCE: I consider the exhibition of last evening very successful, but not one that would call out much discussion. It brought to mind very forcibly the contest that occurred many years ago regarding the theory of development. It may not be uninteresting to those present to give a short sketch of the difference between the two theories that were advanced some two hun-

dred years since. When Harvey, the discoverer of the circulation of the blood, had finished that work, and Leuwenhoek had invented the microscope and placed it before the scientific world, Harvey, in 1651, procured the instrument and took it into his laboratory. He also took, as it is stated, a hen and twenty-one eggs, setting the fowl. Every day an egg was broken and record made of the change that took place in the ovum toward the development of the chick, until the period of incubation was completed. When this was done, he said to the scientific world, "Syngenesis, the already formed, is not true, while epigenesis, to be formed, is true." The scientific world, the Church, and the clergy resisted this encroachment upon formed opinions, and the injunction was, "not to publish it; it is contrary to all ideas of theology and of truth," and it was not published. He dared not proclaim publicly the result of his investigations. So this early biological work never saw the light. That was in 1651, those records lying quiet for one hundred years. In 1759, one hundred and eight years afterward, Friedrich Caspar Wolff, of Germany, took the subject up, and demonstrated that "Dr. Harvey was right," and insisted upon the recognition of that fact. He went through the same experiments, taking only one organ,—the alimentary canal,—illustrating the changes in this organ from the beginning to the end. And yet this was as late as 1759. The masses said "syngenesis" was right and that "epigenesis" was wrong; that the animal was formed complete in the egg, and was not to be formed. Wolff said it was to be formed; that every organ has to be, and was not previously formed. Haller, the greatest physiologist of the time, declared that every animal was created in the beginning, and necessarily limited in number, so it could not be otherwise. He went so far as to state that in the ovaries of the first woman, Eve, there were two hundred billions perfect human beings, and that when those were all born, that would be the end of the human family. This was published in 1728, in opposition to the theory of "epigenesis." Friedrich Caspar Wolff for thirty years taught the truth of epigenesis, but not until 1759 could Wolff get the physiologists of his day to recognize the truth of Harvey's statement, confirmed by his own work. So to Harvey first, and to Wolff afterward, more than any other physiologists, are we indebted for the theory of "epigenesis." It is the theory of "epi-

genesis" which we to-day accept and which we had so beautifully illustrated last night. The organ is to be developed, and is not already developed. When I first realized these facts, some three or four years since, it was a surprise to find that so recently was the truth concerning the development of the animal recognized. You are all familiar with the fact that Spaniards give their children their mother's name. This is evidently the result of the supposition that the mother was the only parent whose traits were transmitted; that the father simply stimulated the development. This theory was held as late as 1789. That has been somewhat, also, I think, the foundation of a theory that is held to-day, that acquired characteristics cannot be transmitted. It is a theory that is strongly opposed by scientific men, but it has had many strong arguments in its support.

Now, to say a word regarding the exhibition last night, I do not know that those who witnessed it recognized how impossible it was to show the development of the enamel. We had shown to us only the space where the enamel-germ existed. Dr. Broomell tried very hard to get a photograph of that structure forming, but the very moment he exposed it it contracted, and those of you who are familiar with the tissues, when you saw the pictures, saw the open space above, and did not see the enamel-germ or stellate reticulum at all. The very moment it is exposed to the air contraction takes place; therefore we had in the photograph the open space. That is the case in every one of those specimens. The stellate reticulum, that was instrumental in producing the calcoglobulin, that went to consolidate the enamel-fibers or the ameloblasts, could not be shown. Those of you who have examined cut specimens of enamel-fiber or enamel-structures find that is the case in nearly all prepared specimens.

I wanted to say a word last night to commend the exhibit of Dr. Broomell, because I know the intense and persistent labor involved in preparing such a display. He has done it with the utmost care, and I think we have never had an exhibition of this kind, giving us in its entirety the structure of the tooth. We have had sections, slices, etc., but never before an effort to show the tooth. I think the doctor is entitled to very great praise and high commendation for the effort he has made, and in which he has been so successful.

SECTION VI.

PHYSIOLOGY AND ETIOLOGY.

REPORT BY J. D. PATTERSON, CHAIRMAN OF THE SECTION.

THE etiology and physiology of the oral cavity grows in importance with increased dental knowledge, and of the dentist who is in reality a professional man, more education in these important fields is year by year demanded.

We cannot separate the knowledge of the causation of disease demanded of the physician and surgeon, or the physiology in organized bodies from that which is demanded of the doctor of dental surgery. They are one and the same, save with a difference in anatomical locality. The most ultimate ramification in the wonderful physiological processes, or the most minute cause which impairs function must ever be part of a great whole, and cannot be understood by study of only one variation or branch of these extensive subjects.

For the dental surgeon the researches of late years in the field of the physiological germicidal action of the blood have been of absorbing interest. In the report of this Section for 1895 it was predicted that the dental profession would make practical application of the discovery of the efficiency of nature's germicide.

In the literature which has come to us during the past year, we glean from the *Annual of the Universal Medical Sciences*, Dr. Sajous, editor, the following upon phagocytosis: "The controversy as to the part played by phagocytes still continues." Metchnikoff is chief, of course, for the phagocytes, and Pfeiffer chief of the opposition. They each have many supporters. Pfeiffer

claims that the destructive processes come "through extra cellular action, and that the serum alone exerts bactericidal power;" that the dead germs, which he, with Metchnikoff, acknowledges are found within phagocytes, were dead when they were surrounded or taken in,—killed by the serum.

Connected closely with this question is the one of "immunity" and what part antitoxins play. Büchner, 1896, thinks that immunity is not the result of a direct action of the antitoxin upon the toxin, but that "both act antagonistically upon the cells of the human system." Kosséll "looks upon the bacteria-destroying power of nucleinic acid as playing a part in the development of immunity." Metchnikoff agrees with this because it gives a part to phagocytosis in the acquisition of immunity. Roux "likewise looks upon immunity as due to cell activity." Editor Sajous says, "The preponderance of evidence gives nucleinic acid the greater part in immunity. The question, however, as to whether the acid acts exclusively as a bacteria-destroying agent, or if, by its acidity, it neutralizes the toxins, remains unsettled."

In the *New Surgery*, issued since our last meeting, edited by Dr. Roswell Park, we find on page 312 the following of interest to the dental surgeon: "The study of the bacteria of the mouth is of great interest to the surgeon. The relationship between mouth bacteria and local lesions of the teeth and jaws and mucous membranes, of secondary gastric disturbances, and the study of the mouth as a first point of infection for both local and general diseases, is a wide subject. Suffice it to say that, normally, the mouth contains scores of varieties of bacteria,—saprophytic usually, but including also common pathogenic forms, which may be found as normal inhabitants of the mouth without injury to the individual,—but if the vitality of the tissues is lowered to a sufficient degree, these pathogenic germs may find a favorable breeding-ground for the production of disease. The mouth furnishes a point of infection for most pathogenic germs,—*e.g.*, those of diphtheria, erysipelas, actinomycosis, the oïdium albicans of thrush, tubercle bacillus, and the virus of syphilis."

In passing, it may be remarked that the enemies of the therapeutic system, which has been built up on the basis of bacteriology, are still, as ever, very active. Leibrich still declares that the Koch system of treating tuberculosis has no prospect of ultimate success.

The consensus of scientific opinion, however, is largely upon the side of the bacteriological factor in the majority of diseases.

In the literature which has appeared since our last meeting, one year ago, bearing upon the subjects of this Section, we note an essay upon "Experimental Study of the Different Modes of Protecting the Oral Cavity against Pathogenic Bacteria," by A. C. Hugenschmidt, M.D., D.D.S., Paris, France, *Dental Cosmos*, October, 1896. An interesting statement in this essay is that after certain oral operations, such as the extraction of a tooth, the soft parts of the injured territory often present the appearance of an ugly wound; and when we think of the pathogenic germs often found in the mouth, it is difficult to understand why such an exposed wound is not more often the seat of severe local trouble, or that it does not bring on a general infection of the economy.

There is no doubt that the severe local inflammations which sometimes arise are because of this invasion, and the operator should take all precaution. Usually the phagocytes and the chemico-tactile and mechanical properties of the oral fluids prevent injury. The entire article of Dr. Hugenschmidt upon the wonderful immunity of the oral cavity and the reasons for such immunity is of absorbing interest to the dental surgeon.

We note an article upon "Diseases of the Oral Cavity a Potent Factor in General Disease," by Dr. S. W. Foster, Atlanta, Ga., read before the Dental Section of the American Medical Association, 1897, published in the *Dental Cosmos*, in which the author names the following dental irritations as productive of general disease:

First, dentition. Impacted teeth, causing obscure neuroses; destruction of masticating power, causing dyspepsia and gastritis; general lack of oral hygiene, which poisons nutrition, causing nervous debility and giving down of the vital forces, also consumption. Of this last the author says, "It is rare that we see a consumptive in whom we do not find a typical case of pyorrhea, or at least pus exuding from around the necks of teeth, and it seems that the breathing into the lungs of the effluvia from these suppurating sinuses of the mouth might produce this fatal disease."

We note a paper upon the "Etiology of Fetor ex Ore," by Dr. H. Jerome Allen, M.D., D.D.S., in which especial attention is called to the fact that the most persistent and lasting fetors are due

to the chronic and exudative diseases of the gums, bones, and mucous surfaces. This, we think, will be appreciated by those having pyorrhea under treatment.

In the *International Dental Journal*, December, 1896, is noted an article by Wm. H. Trueman, entitled "Pyorrhea from a New Standpoint." In regard to etiology, the author strongly inclines to the belief that the disease is a germ infection. He says, "We may remember, also, that of all germicides known to science, none are so potent, so thoroughly reliable, or so universally accessible as are the natural secretions of a healthy human mouth. Were it otherwise, it would be utterly impossible to find a healthy individual among the many thousands who are compelled to daily breathe the germ-laden dust of a large city. It is only when the germ succeeds in quickly finding a little pouch in which to hide, secure from this, to it, destructive secretion, or when by mere chance it obtains foothold, while the potency of this secretion is temporarily impaired, that it has the slightest chance to begin its destructive work. Once firmly settled, it begins to thrive, and a colony once formed creates conditions that may successfully combat its untoward surroundings. Changes constantly taking place in the oral secretions —now favoring and now opposing—fully account for the ebb and flow that marks, in its earlier stages, this disorder. The ravages of the disease, never wholly obliterated after it has once been firmly established, are ever an open door inviting the frequently noted relapses, until the complete loss of the teeth destroys forever its once favorite camping-ground."

We note a paper upon "Pyorrhea Alveolaris," by Dr. Geo. B. Clement, Macon, Miss. Dr. Clement claims that the disease is caused by hypercalcic deposit in the cementum and from the cells which form that structure.

"Pyorrhea Alveolaris," by J. W. Wassall, M.D., D.D.S., Chicago, *Dental Review*, June, 1897, in which the writer, speaking of its etiology, suggests a constitutional disorder, found in eczema, which he believes has an important relation to the affection.

In Roswell Park's *New Surgery* is found the following: " 'Stomatitis catarrhalis' is a simple catarrhal condition, resulting from irritation of the mucous membrane from mechanical, chemical, or mycotic causes. It presents the symptoms of a desquamating catarrhal condition."

A paper upon "Pyorrhea Alveolaris," by J. E. Cravens, D.D.S., Indianapolis, *Dental Digest*, August, 1896.

A criticism of the uric acid theory of pyorrhea, entitled "Peculiar Pathological Perceptions," by J. D. Patterson, D.D.S., *Dental Review*, March, 1897.

We further note an essay upon "Stomatitis the Cause of Various Throat Diseases," by Isidore Lett, D.D.S., Philadelphia, *Dental Cosmos*, September, 1896.

In *International Dental Journal* we find an essay upon "Nasal Obstructions which Result in Mouth-Breathing, with Special Reference to Adenoid Vegetations," by George L. Richards, M.D., Boston. The writer has the following to say upon the etiology of nasal obstructions: "The cause is not very clear. Heredity and climate, especially the latter, seem to play a part, as they are found more frequently in the North and on the coast than inland and to the South. Scrofula, measles, scarlet fever, and whooping cough are causative."

An essay upon "Salivary Calculi," by Gustav Futterer, M.D., *International Dental Journal*. In regard to causation, the author gives proof that in a majority of cases the disease arises from calcic matter being deposited in the ducts. He says, "Small pieces of tartar often break down and can very easily enter the ducts, especially Wharton's duct, and here we find the most calculi, which are very rare occurrences in Steno's duct. Gravitation will bring the pieces down to the bottom of the mouth rather than up to Steno's duct; they will remain there longer, and occasion to enter will offer itself more readily." The same rule holds good in animals. The theory that the uric acid diathesis is causative of these deposits is discouraged by the author.

In the *Dental Cosmos*, February, 1897, appears an article by M. H. Cryer, M.D., D.D.S., upon "The Contributions of Dentistry to Surgery." In the domain of etiology, Dr. Cryer states in this article, "When we speak of the connection between surgery and dentistry, we generally look at but one side,—the extension of dental disease to other parts; but there is another feature to be borne in mind,—the fact that disease processes in other parts of the cranium may affect the teeth through extension from comparatively distant anatomical parts. In an address delivered at the 1895 meeting of the American Dental Association I called attention to

the fact that the infundibulum leading from the frontal sinus frequently opens, not into the middle meatus of the nasal chamber, but into the upper anterior portion of the maxillary sinus. I have seen several cases in which this anatomical feature has had a direct clinical bearing. Catarrhal disorders, which were first evident in the region of the frontal sinus and anterior ethmoidal cells, have become chronic; later, evidences of disorder have become manifest in the region of the antrum, causing a feeling of heaviness and dull pain. After a period some of the posterior teeth give evidence of pericementitis, without any evidence of caries or any history of injury. In some of these cases pus may be found exuding from about the neck of a tooth or teeth. An inflammation of the lining tissues of the antral wall has caused closure of the arteries supplying the pulps of the teeth, which have died, and septic inflammation has ensued. An examination by electric light will show the presence of an exudation in the antrum, and in some cases the extraction of a tooth may be followed by an escape of pus and mucus from the antrum."

"The Relation of the Teeth to the Ear, Nose, and Antrum," by O. F. Gambati, M.D., Houston, Texas. The particular phase of thought found in this paper may be said to lie in the claim that an empyemic condition of the antrum sets up a pathological condition of the teeth.

In the *Practitioner and Advertiser*, July, 1897, the editor, Dr. W. C. Barrett, in speaking of the etiology of "Diseases of the Maxillary Sinus," says, "Renewed attention has been directed to the fact that a diseased condition of the frontal and other sinuses is sometimes present, thus preventing disease supposed to be wholly in the antrum. When the case is obstinate it is recommended that other cavities which may drain into the maxillary sinus should be exposed."

In February *Dental Cosmos*, 1897, James S. Gilliams, M.D., D.D.S., relates a case of "Herpes Zoster Associated with Dental Trauma," in which the eczema appeared upon the left temple and involved the eye, caused by a diseased left superior cuspid, and which trouble disappeared upon the extraction of the tooth. The distant trouble is thus diagnosed by the author: "The diagnosis of this case is one of considerable interest. It may fairly be assumed that the injury from the diseased tooth set up a neuritis which ex-

tended, first of all, to the temporal terminations of that nerve, and subsequently involved the supra-orbital branches of the ophthalmic or first division of the fifth. The cutaneous branches of the supra-orbital nerve supply the integument of the cranium as far back as the occiput, and some of its branches are distributed over the frontal and parietal bones. From the excruciating character of the pain within the cranium and the inflamed condition of the eye, it is probable that the neuritis affected not only the peripheral terminations, but also the trunks of the supramaxillary and ophthalmic branches of the fifth nerve."

"Cancer of the Lip," by C. L. Gibson, M.D., New York City, *Dental Cosmos*, June, 1897. The causation of this disease is noticed as follows: "As regards the causes of this disease, to traumatism, in general, is ascribed the chief place. The lips are easily abraded, cracked, chapped, burned, and otherwise maltreated, so that abundant sources of irritation are furnished. As regards the element of heredity, there is an ever-increasing tendency to belittle its importance. It is undoubtedly true that the belief in heredity, so strong until recent years, was based to a great extent on tradition. The strong efforts which we are all making to place medicine upon the plane of an exact science discourage the acceptance of vague theories and histories concerning cancerous relationship, and, subjected to an exact scrutiny, the family history of cancer is reduced to so small an extent as to be looked upon only as an interesting coincidence." The author also points out that it is startling to see how many cases of lip cancer have been "acquired by living in dwellings previously occupied by the subjects of cancer."

"Dentistry and its Relation to Medicine" is the subject of a paper by Archibald Dunn, M.D., in *Dental Practitioner and Advertiser*, April, 1897, in which the author cites two recent cases in his practice: One in which hemicrania was caused by an obscure cavity in the buccal surface of an upper third molar, and one in which convulsions and epilepsy had causation in a filled lower molar.

As Chairman of this Section, I have in no way covered the field of etiology and physiology for 1896-97 as the subjects deserve, but have only noticed essays which have come to my notice, which seemed to bring out some new, or comparatively new, line of thought.

DISCUSSION.

DR. PEIRCE: I wish to allude to one matter touched upon in Dr. Patterson's report, and that is the formation of tartar or salivary calculus. I think the dental profession have been indifferent in expressing the cause of its deposit upon the teeth. Almost every teacher to whom I have listened has simply spoken of it as a deposit, an amorphous precipitate, and not indebted to any organisms in the mouth for its character or quantity. I had accepted this theory for several years, but it has recently been my effort to try to ascertain whether the tartar upon the teeth was simply a precipitate of the lime in the saliva, or whether its deposition was due to organisms in the saliva. A quantity of saliva placed in a vessel out of the mouth, though it may be loaded with lime, will not deposit that lime unless it is treated with carbonic acid gas, or an organism establishes the conditions which prevail in the mouth. Hence, I desire to announce that I believe the deposition of lime upon the teeth is due not only to the presence of lime in the saliva, which is, of course, an essential, but also that the organisms must also be present. Two patients, in whose mouths there was a profuse and rapid deposition of tartar on the teeth, were asked to keep their mouths as pure as possible with a strong antiseptic, for a limited time, being between two ordinary visits to my office for the purpose of having the calculus removed. The care exercised in keeping the mouth saturated with a strong antiseptic, without interfering at all with the natural secretion of the saliva through the glands, prevented the deposition of the lime upon the teeth to such an extent that I was satisfied that the deposition of lime was due not only to its presence in the saliva, but also to the presence of an organism. That was the fact I wanted to bring out, and I wanted to know if any one else had had the same experience. Of course, there are mouths in which no tartar is deposited on the teeth, because there is no excess of lime in the saliva; but if, in a mouth where there is an excess of lime in tne saliva, you can prevent the growth of organisms, and especially of leptothrix, which is a benign organism (not at all instrumental in producing caries), but which induces an alkaline condition by its presence, you retard the deposit of the calculus. That organism, leptothrix, is, in my opinion, instrumental in the deposition of lime.

DR. GUILFORD: Have you any idea how they act to produce that?

DR. PEIRCE: I have not. I remember Professor McQuillen, a year or two before his death, prepared a paper on tartar on the teeth, his idea being that it was due to the action of an organism like the coral; but he did not sustain his theory, because he was unable to demonstrate the presence of any such organism. He assumed that to be the condition, and read his paper before the Academy of Natural Sciences. If any gentleman here will take a patient from whose mouth he has been in the habit of removing tartar once a month or once in two months, and will have the patient use a strong antiseptic,—for instance, simply alum, which will not dissolve the enamel of the teeth, but which is a good antiseptic,—he will, I think, realize the truth of my statement. Or, he may take another antiseptic, boracic acid and gaultheria, pretty strong, with the same result. It cannot have any influence in destroying lime in the saliva, but it has influence in destroying micro-organisms and preventing them from aiding the deposit upon the teeth. I have been trying to get at the facts by some experiments, and the result of my investigations so far is that salivary calculus is due to an organism, as well as to the lime in the saliva. You may have the lime, but without the organism you do not have the deposit.

DR. BARRETT: Mr. President, I should hardly be inclined to coincide with Professor Peirce in the deductions or conclusions at which he has arrived, for two or three reasons. How can a micro-organism produce any kind of deposit, or any kind of change? That is, how, for instance, does the yeast plant produce its characteristic by-products, alcohol and carbonic acid gas? By decomposition of the medium in which it grows, precisely as the potato decomposes the inorganic elements of the earth, taking into its own organism that which it needs. So does the micro-organism. Both are vegetable in their nature, except that one is a cryptogam and the other is a phanerogam. In proliferating it decomposes the menstruum in which it grows, taking what it wants, and the excluded atoms forming new combinations, thus giving rise to the characteristic by-product. That may be a ptomaine of such exceeding power that we can scarcely form a conception of its potency. For instance, take one single ptomaine,

the characteristic by-product of the bacillus of tetanus. Of that ptomaine the quantity represented by the decimal .00000001 of a grain is poisonous. But, as one of the fungi, this action is necessarily confined to organic matter. The coral, to which Dr. Peirce refers, is able to act on inorganic matter.

DR. PEIRCE: I did not say it acted like the coral. I said Professor McQuillen said that.

DR. BARRETT: The function of the coral is to crystallize inorganic matter, and this changes the whole relation. For instance, the deposition of calcic material that takes place in the presence of albumen is utterly different from that which occurs in inorganic matter. In the presence of albumen calcic matter assumes a definite, concentric form, and it becomes the calcoglobulin of the salts of the teeth; but in the exclusive presence of inorganic matter it becomes a mere amorphous precipitate. Now, the deposit of salivary calculus takes place in the presence of organic matter; hence the product formed, if the theory of Dr. Peirce is correct, will necessarily be crystalline, or at least be quite structural, which is not the case with the tartar of the teeth.

But the presence of salivary calculus is accounted for in another way. The carbon dioxid of the breath, meeting the saliva, which contains the lime, neutralizes the combining acid, and the calcific material is thrown down as an amorphous precipitate. So the tartar is amorphous in its character. I should not be inclined to accept Dr. Peirce's hypothesis without further inquiry, because the deposit of tartar on the teeth is accounted for on another hypothesis, and also because the theory of Dr. Peirce does not seem to me consistent with known facts.

DR. TAFT: The idea that organisms have a part in the precipitation of calcareous material upon the teeth is, in some degree at least, new. It will be remembered that when the saliva passes out of the salivary ducts its environment is changed. Its temperature is lowered, especially in the case of mouth-breathers. It comes in contact with and is mixed in the mucus of the mouth, which changes its chemical character somewhat. It is also in contact with the atmosphere, and absorbs oxygen from it. The change in these respects is sufficient to cause precipitation of calcareous material, which has been held in solution in the saliva, but, owing to the changed environment of the saliva, it is no longer able to hold in solution the salts of lime.

Saliva contains carbonic acid gas, which is in a degree eliminated, and becomes neutralized after the fluid passes into the mouth. That is an important factor in the retention of the lime-salts in solution. In the steam boilers, and in vessels in which water containing lime is boiled, rapid precipitation of lime takes place. The influence of bacteria or any organisms is very slight in the precipitation of lime from the saliva. It takes place chiefly because of the admixture of other substances with the saliva, the reduction of temperature, and the absorption of oxygen; and the precipitation, so far as it comes in contact with surfaces favorable for its lodgment, adheres and accumulates in quantity more or less rapidly. The precipitation of calculus upon the teeth is not very rapid usually; it varies, however, considerably in this respect. It requires weeks, months, and sometimes years, to produce any considerable amount of calcareous deposit on the teeth. There are exceptional cases where even in a few weeks a large amount of deposit of this material, mixed with other substances in the mouth, will be formed on the teeth, but ordinarily the dense varieties of this material require a long time for accumulation.

Professor Peirce has referred to the use of an antiseptic for the purpose of destroying the supposed influence of micro-organisms. This antiseptic is applied with a tooth-brush, is it not?

DR. PEIRCE: No, I have recommended that it be used as a wash in the mouth, taken right from the bottle.

DR. TAFT: Well, may not the material used as an antiseptic so change the saliva as to prevent the precipitation? No doubt, a large share of this calculus which is thrown down is not deposited upon the teeth, but only that which comes in contact with their surfaces at points where there is little friction, and no condition that would prevent its attachment. This is, of course, a subject worth studying, but it had not occurred to me that organisms played any considerable part in the precipitation of salivary calculus upon the teeth.

DR. PEIRCE: It is worth investigating.

DR. PATTERSON: I do not know that I care to add anything to what has been said. The subject of calcic deposits was not brought up in the report at all in this way. It was, I think, only in regard to obstructions in the ducts, so that really this matter is outside of the report.

I should hesitate a long time before believing in the theory put forth by Dr. Peirce. In the first place, I think he starts upon a proposition which is totally wrong,—namely, that in a solution containing these inorganic materials outside of the mouth we will not find this precipitate. Not a winter passes in which I do not make the experiment myself, because I lecture on that subject in our college, and my experiments show that that thing does occur. So his statement that no such thing occurs is new to me. Deposits take place upon certain rods which I place in the solution. I think the doctor's premises are wrong. After the study that I have made of micro-organisms, I do not see how it is possible for them to have a part in causing this deposit; at least not on account of their effete products, which we find manifesting themselves in pathological conditions and causing disease in the various tissues.

The subject of etiology is a very interesting one to me, and I have been discouraged in trying to make up this report, because we have not had the assistance desired from those to whom I appealed. The subject is of peculiar interest to me just now, on account of some local experiences which we have had in the vicinity of Kansas City. In the last two years a number of suits have been brought for malpractice against dentists in Kansas City and in the State of Kansas. Only last week one of my friends was mulcted in damages. Suit was brought for $6000, and the jury gave a verdict for $2000. In another case in Kansas City, where suit was brought to recover $6000 damages, a verdict of several hundred dollars was rendered. In other cases decisions are not yet reached. The question in one case which went to the jury, and which that fool jury had to determine upon, was as to what caused the trouble in the jaw, resulting in the loss of teeth and the loss of the process. Damages were given on account of the belief that the instrument, the hypodermic needle, used in injecting a solution to produce anesthesia of the parts was infected. The question was gone over for several days, physicians and dentists being called as witnesses to state the various theories in regard to the etiology of the trouble. This case and the other cases have been of great interest to me. I do not know what we are going to do if ignorant juries are to be left to decide such questions, which can only be understood as the result of the most careful study and training.

DR. PEIRCE: Educate your judges.

DR. PATTERSON: The case goes to the jury anyhow. The jury decides what the etiology of the trouble was.

DR. PEIRCE: Our judge says there must be thirteen men to decide a case in our court.

SECTION VII.

ANATOMY, PATHOLOGY, AND SURGERY.

REPORT BY W. C. BARRETT, CHAIRMAN OF THE SECTION.

THERE is no Section of this Association to whose papers and debates more time should be assigned than to those of Section VII. And I may with entire truth say that none has been accorded a greater share of the attention of the members. Anatomy must, of necessity, form the basis of all our operations and treatment. Pathology is the study of all the functional changes which make necessary the services of the dentist, while to surgery we must, of necessity, look for a large share of reparatory treatment.

My conception of the principal office of these Sections, and especially of the reports from each, is a review of what has been in the recent past accomplished in each field. Properly to perform this task would take too much of the time of the Association, and I shall, therefore, but briefly summarize a few salient facts, and leave the rest to be brought out by the essayists and in the discussions.

It might be imagined that but little could be said concerning human anatomy. We are often reminded that there has been but little change in the bodily structure for some time. But there has been a great advance in our comprehension of it, and I believe that the most important facts of the past few years have been brought out through the studies and observations of dentists.

The general idea of the structure and function of the antrum of Highmore has, I believe, been wrong in the past. The text-books have given faulty instruction concerning it, and they have

recommended impracticable operations, because of these misconceptions. At the meeting of the Association held at Asbury Park, two years ago, Dr. M. H. Cryer, of Philadelphia, presented to this Section a paper upon "The Anatomy of the Sinuses Connected with the Oral Cavity," illustrated by photographs projected upon a screen by the stereopticon, and by the dissections themselves, that were a revelation to many.

He showed that our previous ideas regarding the antrum were very crude and incomplete. He demonstrated that the foramen of that cavity was nearer its apex than we have usually believed, and he also showed that in many cases, at least, the infundibulum leading from the frontal sinus, instead of opening into the nasal meatus, discharged directly into the antrum, and that in this peculiarity might be found the reason for many of the incurable cases that have been reported.

Dr. Cryer also showed preparations of the inferior maxilla that have enlarged our ideas of the occasional abnormalities that appear in the structure of the inferior dental canal.

At the meeting of the Association held last year, at Saratoga, Dr. Thomas Fillebrown, of Boston, read a paper and presented illustrations that still further increased our knowledge. Taking up the same subject, he showed by dissections that had been made under his directions, and by stereopticon slides, that the discharge of the infundibulum into the maxillary sinus was yet more common than Dr. Cryer had believed. He showed that as a normal condition the unciform process was continued by means of a membranous extension until it almost precluded any discharge from the frontal sinus finding its way into the nasal cavity until the maxillary sinus had filled to overflowing.

Neither of these papers has received the attention to which its merits entitle it. Dentists yet go on treating antral disease according to the old drastic measures, utterly regardless of these distinct advances in knowledge. They insert drainage-tubes and drench the sinus with powerful remedies in the good old way, just as if Cryer and Fillebrown had made no illustrative studies. There is no use in having such observations made, or in the presentation of new facts, if they are to be ignored and practitioners are to learn nothing from them. We shall never be a profession in fact, and our practice will never rise to its proper

importance, until dentists are keenly on the alert for any new discoveries, and ever ready to take advantage of them.

In pathology there have been many distinct advances,—more than there is time for me here to consider. It is one of the most prominent indications of the distinct progress of our specialty that we are paying increased attention to pathological conditions. Our colleges are teaching pathology as a distinct branch of study, and our practice is thus constantly being broadened. Some dentists have cried out in alarm that our schools are turning out students at a rate that will soon breed starvation to the whole profession. I can but think this a very narrow view to take of professional matters. The truth is, the colleges are broadening and deepening the stream much faster than they are peopling it with occupants. So much has dental practice been extended, that there is now room for ten dentists, where but a few years ago only one could live. The next generation will see dentistry much more expanded, and the time will arrive when all the diseases of the head and its cavities, aside from that of the brain, will be relegated to dentists, who have been made quite competent for this specialty by schools that teach something more than mere mechanics.

The advances made in anatomical knowledge, to which I have already referred, must necessarily modify our views of the pathology and treatment of diseases of the maxillary and frontal sinuses. These have, in the past, been a great bugbear, and our lack of comprehension has greatly complicated our practice. In my opinion, antral treatment should be much more simple than most dentists believe, when the disturbances are uncomplicated with trouble in the frontal sinus. I do not believe that in the simple degenerations induced by catarrhal conditions, and which, I think, form by far the greater proportion of them, anything more is needed than proper drainage and douching with a simple cleansing fluid, like tepid water containing a little common salt. I believe that the drainage-tubes so commonly inserted are a positive injury, and that the injection of hydrogen peroxid and pyrozone preparations are, to say the least, of doubtful utility.

In surgery, the advance of the last half-decade has been remarkable. In no part of the whole general practice has this been greater than in oral surgery. Dentists are coming forward and

occupying the field which they should have cultivated years ago. The general surgeons in most of our larger cities are now referring to the oral specialist operations that, ten years ago, they would almost as readily have sent to the drug clerk. And why should this not be the case to a greater extent than it now is? The general surgeon seldom attempts operations in gynecology. They are referred to the specialist. The oculist now looks after all surgery of the eye, and usually of the ear. To the orthopedic surgeon are referred deformities of the extremities, and to the dermatologist the removal of superficial growths. Why should not the oral surgeon take up all operations upon the organs and tissues to the study of which he devotes his life?

It has often been argued that dentists are not worthy the name of professional men, because they have no regularly organized benevolent dispensaries,—that they do little professional charitable work. It is a basal truth that upon all real professions and professional men the poor have an indisputable claim. No medical man has the right to withhold his professional services from a suffering individual because he is without the means of recompense. The lawyer recognizes the right of the penniless person to advice gratis at his hands when his personal or property rights are invaded. The courts assign counsel to accused or legally involved people who are without legal advice, and the lawyer who should refuse to accept and give his best services to such poor people might be disbarred from practice. No clergyman would deny religious consolation to any one who needed it, and the more deserted and friendless he might be, the more imperative and incontestable would be his claim.

Dentistry, which loudly demands public admission of its professional status, has so far done little for the poor. We recognize, and ask others to recognize, the necessity for dental services in the promotion of the health and comfort of the public, but we have, so far, done almost nothing toward extending it, unless we were well remunerated for it. If we are to claim a professional status, this should be remedied. Competent dentists and oral surgeons should accept and even seek for positions upon the staffs of hospitals, and should then give enough of attention to their duties to insure proper dental and oral services to all hospital patients who demand them. They should qualify themselves

to take entire charge of those, in both the surgical and medical wards, who have any oral diseases whatever. This will give to us the recognition that we demand, and we may all rest assured that, however loudly we may vapor and vaunt our merits, acknowledgment will only come when we have honestly earned it, and when that is done it will not for an hour be denied us.

Brophy's operation for the radical cure of cleft palate dropped like a thunderbolt upon surgery. His proposition to operate within a few hours of birth was at variance with all surgical practice. The very idea of forcibly bringing together the sundered osseous palate-walls, and retaining them until they had united, was something revolutionary. Yet it has proved eminently practicable and successful. As good an authority as the eminent surgeon Senn, pronounces it the greatest surgical advance of the decade. Many dentists are not acquainted with the operation or its advantages. That is a serious reflection upon their own professional knowledge and intelligence. If they are competent practitioners, it is their bounden duty to know the merits or the demerits of every such novelty in practice.

The operation for the resection of the inferior maxillary nerve and artery, devised and presented to medical science by the same very competent surgeon, was another new and startling advance, which commends itself by its simplicity and completeness. It consists in so enlarging the mental foramen as to admit of the passage of a kind of exaggerated Donaldson broach, which is pushed back to the neighborhood of the inferior dental foramen, when by a few turns it engages blood-vessels and nerve together, and they can be completely and cleanly drawn out in the same manner, and quite as effectually, as the dentist removes the contents of a pulp-canal.

This operation offers a complete confirmation of the observation of the anatomists, who claim that all the text-books and preparations that represent the nerves and blood-vessels of the dental pulp as going out at the dental foramen, and traversing the tissues until they join the internal dental artery and inferior maxillary nerve in the inferior canal, are travesties of the truth. By the removal of the whole contents of the canal, the vitality, the innervation, and vascular supply of the dental pulp are not in the least interfered with. The books and artificial preparations should be corrected so as to conform to these facts, and to give the truth,

and that is, that the entire blood- and nerve-supply of the tooth is from the pericementum, which is a kind of placental organ designed, among its other functions, for this special purpose.

In confirmation of the truth of the observations and dissections of Professors Cryer and Fillebrown, Professor Brophy has lately performed another rather novel operation for the relief of empyema of the frontal sinus. I have requested him to give an account of it, and this will form a part of the presentation of the Section.

Scientific dentistry should carry its investigations outside the fields in which it operates for sordid money considerations. The world has a right to call upon it to properly cultivate the field which it has adopted. If we study only the bread-and-butter aspect of our calling, what right have we to say that we are scientific men? If we do not proceed any further, we are only business men, striving to extend the limits of our calling that we may make a little more money in the new fields. We shall never fully comprehend our vocation in all its aspects until we study the teeth as a whole,—until we consider the dental organs of other animals beside man. What would be thought of ophthalmology if it never compared the human eye with those of other animals? Where would be its claim to a professional relation if it looked at nothing but the money side of the calling?

So, if dentistry is to make good its boasts that it is a "scientific," "professional" avocation, it must delve into something beside the pocket. It must study something more than the belly. It must rise to a broad consideration of the correlations of its existence. It must look at the teeth from another standpoint than that of organs to be filed, and scraped, and excavated, and filled, and substituted, for the purpose of supplying pabulum to exercise our own teeth upon. We must go out into the broad field of nature and examine these organs in all their relations. There are none that afford so much light to the anthropologist, and there are none that so plainly evidence the differentiation in species that must have formed so large a portion of the past history of the human race, to say nothing of the other orders and species of animal life. We want to know something of teeth aside from their diseases. Until we rise to this, we will be looked upon as just what, under those circumstances, we would be,—mere mechanics, artisans, workmen by the day, the hour, or the job.

It was with a view to that development of these higher aspects of dentistry that, immediately after the last meeting of this Society and my acceptance of the Chairmanship of the Section, I commenced the work of preparing an exhibition in comparative dental anatomy, that might be illustrative of the various forms of dentition in the different classes, orders, and species of animal life. I have a considerable number of specimens myself, and have been instrumental in placing in more than one institution collections that should stimulate to scientific study. In the rooms of the Odontological Society of the city of New York is a collection that has, so far, been without a rival anywhere in the world, as a scientifically arranged and classified museum of specimens in odontology. Without the facilities and assistance of Ward's Natural Science Establishment, of Rochester, N. Y., I could not have succeeded in getting together that collection, and now they have enabled me to present to the American Dental Association such an exhibition as, I believe, was never before made, and which will be found in an adjoining room.

I am but too well aware that a certain class of men will say of this, as they have said of other exhibitions that I have made before this Society, "Oh, that ain't dentistry!" Well, quite possibly it is not their kind of dentistry.

But I am thankful to say that there is a class of educated, intelligent men coming into our profession, who take broader views, whose dentistry is not quite so narrow as that of the practitioners who have no conceptions of anything save mechanics, and who have so far mistaken the character of their calling as to place it on a par with the vocations of the blacksmith, the jeweler, and the shoemaker.

It depends upon the reception that shall be given this rather novel departure as to whether the time of our National Association shall be mainly devoted to amalgam and red rubber, to mechanical clinics and demonstrations, or to the scientific and educational problems involved. Let it not be understood that I depreciate or undervalue the practical affairs of our profession; but I believe that the time given by our representative men to our national organization should be devoted to the broadest scientific problems. The place for clinics and elementary discussions, for kindergarten work, is in local society meetings. Let us here try

to do something for our national professional fame and for the elevation of the higher interests of dentistry.

The collection will speak for itself. I sincerely trust that it will be carefully studied, and that it will be a source of illumination. To this end I commend it to you all, and hope there is not one present who will not be benefited by it. It was not collected and is not exhibited to gratify mere idle curiosity, but to give opportunity for earnest scientific study.

I have not time here to enter upon any learned disquisition concerning it. You will find it scientifically classified and labeled, and Mr. Charles H. Ward, who is in attendance to exhibit it, will be glad to answer any questions, and I shall be only too happy to explain anything in connection with it at any time when the Association is not in session.

The Section desires to present, for the consideration of the Association, the following papers:

By C. N. Peirce: "Structural Development."

By T. W. Brophy: "A Case of Antral Disease Involving the Frontal Sinus."

By Thomas Fillebrown: "Continued Study of the Relations of the Frontal Sinus to the Antrum."

By Mr. Charles H. Ward: "Human Teeth from a Comparative Standpoint."

GLOSSARY

FOR THE ODONTOLOGICAL COLLECTION EXHIBITED IN SECTION VII OF THE AMERICAN DENTAL ASSOCIATION, AT OLD POINT COMFORT.

ACRODONT. Having the teeth attached to the edge of the jaw by their bases, without bony alveoli on either the inner or the outer side.

THECODONT. Having the teeth lodged in alveoli.

PLEURODONT. Having the teeth ankylosed by their sides to inner sides of the jaws.

BUNODONT. Having the crowns of the molar teeth elevated into tubercles; having tuberculated molars.

PTYCHODONT. Having the crowns of the molar teeth folded.

LOPHODONT. Having the crowns of the molar teeth thrown into crests or ridges, longitudinal or transverse; opposed to bunodont.

HAPLODONT. Having the crowns of the molar teeth simple or single; that is, not divided into ridges or tubercles.

SECODONT. Having molars in which the tubercles are modified for cutting.

MESODONT. Having medium-sized teeth, as in the Mesodont races.

MICRODONT. Having short or small teeth.

MEGADONT. Having large teeth.

GNATHIC INDEX. The ratio of the distance between the basian and the alveolar point, to the distance between the basian and the nasal point.

ORTHOGNATHOUS. Straight jaws; having the profile of the face vertical, or nearly so, in consequence of the shortness of the jaws, which constitutes orthognathism; having a gnathic index below 98.

MESOGNATHIC. Having a moderate or intermediate gnathic index of from 98 to 103.

PROGNATHIC. Having protuberant jaws; having a gnathic index of more than 103.

PALATO-ALVEOLAR INDEX. The proportion between the length of the horizontal plate of the superior maxillary and the width of the superior alveolar arch, measured at the middle of the buccal face of the second molar.

PARABOLIC ARCH. A form of contour of the inner border of the superior alveolar arch in which the arms diverge, but with such a curve that if prolonged they would eventually return upon themselves and meet.

HYPERBOLIC ARCH. A superior alveolar arch whose branches diverge in a backward direction.

ELLIPTICAL ARCH. When the branches converge, whatever the degree of such convergence may be.

FLOWER'S DENTAL INDEX. The proportion between the molar series, measured in a straight line, from the anterior face of the first premolar to the posterior face of the third molar, and the length from the basial to the nasal point.

SYMPHYSIAN ANGLE. The angle which the long axis of the symphysis of the jaw makes with the horizontal rami.

MONODELPHIA (single uterus). The highest of three primary divisions of mammals; placental mammals.

DIDELPHIA (double uterus). Implacental mammals; the Marsupials; mammals that bring forth their young but partially developed.

ORNITHODELPHIA (bird uterus). Mammals having but a single opening for the intestinal, generative, and urinary organs, the Monotremata. Their young are incubated outside the body.

MONOPHYODONT. Having but one set of teeth; having no deciduous dentition.

DIPHYODONT. Having two sets of teeth; a deciduous and a permanent dentition.

HOMODONT. Having teeth all alike, as in some fishes, reptiles, etc.

HETERODONT. Having the teeth differentiated into several distinct kinds, as incisors, cuspids, premolars, and molars; opposed to homodont.

ARTIODACTYLA. A sub-order of ungulate, or hoofed animals, which has an even number of toes, or toes in pairs (two or four). All the ruminants and hog-like ungulates are artiodactylic.

PERISSODACTYLA. A sub-order of ungulates which is distinguished by having an odd number of toes,—one like the horse, three like the tapir or rhinoceros, or five like the elephant.

PINNIPEDIA. The pinnigrade, pinniped, or fin-footed aquatic carnivorous quadrupeds; having the feet modified as flippers, like the seal and walrus.

FISSIPEDIA. A sub-order of the carnivora, with toes separated and adapted to walking. It includes all the terrestrial carnivora.

PLANTIGRADE. Walking upon the whole sole of the foot, as bears, raccoons, man, etc.

DIGITIGRADE. Walking upon the ends of the toes, as the horse, hog, and all the carnivorous animals. The digitigrades are the fast runners.

DIASTEMA. An interval between any two teeth or sets of teeth, especially the cuspids and the premolars.

CATALOGUE.

Catalogue of a collection of Human and Comparative Odontology, exhibited in Section VII, Anatomy, Pathology, and Surgery, W. C. Barrett, chairman, at the thirty-seventh annual session of the American Dental Association, at Old Point Comfort, Va., August, 1897; prepared, mounted, and exhibited by Ward's Natural Science Establishment, Rochester, N. Y.

Identification of species, zoological and odontological classification by Charles H. Ward, anatomist, and Henry L. Ward, paleontologist.

HUMAN ODONTOLOGY.

I. Developmental Series.

Human fetus, no teeth erupted.

Germs of teeth, mounted in dental arcade, fetal.

Infant at birth, jaws dissected to show germs of teeth.

Infant four months old, incisors about to erupt.

Infant about two years old, component bones differentiated by colors.

Italian girl, five years seventeen days old, jaws dissected to reveal permanent teeth in process of development.

European girl, fourteenth to sixteenth year, third molars not yet erupted and maxillary tuberosities undeveloped.

Adult European man, permanent denture.

Perfect permanent teeth mounted in dental arcade.

Adult European man, horizontal dissection through alveoli and roots of teeth.

Adult European man, jaws vertically dissected, showing teeth in situ, pulp-cavities, etc.

Aged Negro, progressive absorption of alveoli.

Aged European woman, edentulous, complete obliteration of alveoli.

II. Abnormal Series.

Suppression of superior lateral incisor, European man.

Suppression of left superior first premolar and transposition of first and second right superior premolars, European man.

Impaction of left superior canine and of left inferior first premolar, European man.

Osteology of single hare-lip, superior maxillæ, European.

Torus palatinus of Harrison Allen, Mulatto girl.

Deciduous molars abnormally persistent, lower jaw of child.

Hyperostosis of external walls of alveoli, European man.

Hyperostosis of inner walls of alveoli, lower jaw of European.

III. Pathological Series.

Caries, European man.

Pyorrhea alveolaris, European man.

Green-stain, European man.

Enamel showing pits, grooves, and corrugations, European woman.

Corrugated enamel, European woman.

Alveolar abscess of lower jaw, European woman.

Alveolar abscess of superior maxillary, with impaction of superior incisor, American aborigine, coast of California.

Disproportion between size of teeth and jaws, wide diastemas, European man.

IV. Series Illustrating Palate Variations.

(a) Typical forms:
Flat palate, Maori woman, North Island, New Zealand.
Gothic palate, European woman.
V-shaped arch, European man.
Horse-shoe arch, European man.
(b) Forms of superior alveolar arch recognized by Prof. Broca as constituting ethnological characteristics:
Parabolic arch. European man.
Hyperbolic arch, European man.
Elliptical arch, aboriginal man, New Caledonia.
U-shaped arch, Mallicollo Islander, New Hebrides.
"The first two and noblest forms are common in the white races; the third and fourth are rare, and are especially seen in black races."—*Topinard.*
(c) Palato-alveolar index of Prof. W. H. Flower:
Palato-alveolar index 103.4. Dolichuranic, native woman, Fiji Islands.
Palato-alveolar index 114. Mesuranic, Maori man, Chatham Islands, New Zealand.
Palato-alveolar index 121.8. Brachyuranic, native Australian man, New South Wales, Australia.
A chart accompanies the latter series, showing points of measurements and the arbitrary divisions into which the index is divided.

V. The Wear of the Teeth.

The method of scientific measurement of the degrees of wear of the teeth, as defined by Broca, is explained in a chart. It is also illustrated by the following series:
First degree of wear, Irish-American girl.
Second degree of wear, European man.
Third degree of wear, native Australian man, Mt. Forbes, Australia.
Fourth degree of wear, American aborigine, Channel Islands, coast of California.

VI. Prognathism.

The Gnathic index established by Prof. W. H. Flower, to determine the amount of superior prognathism, is illustrated both by a chart and by the following series:
Orthognathous, European woman, gnathic index 94.5.
Orthognathous, white child at birth, gnathic index 96.4.
Mesognathous, negro at birth, gnathic index 98.1.
Mesognathous, Kanaka man, Sandwich Islands, gnathic index 99.
Prognathous, Papuan man, New Ireland, gnathic index 103.8.

VII. The Dental Index.

Prof. W. H. Flower's dental index is perhaps one of the most important of the physical criteria used in differentiating races according to their position in the scale of civilization. The details are explained by a chart, and the sub-divisions recognized are illustrated by the following series:
Microdont, Maori man, Chatham Islands, dental index 40.7.
Microdont, head of Egyptian mummy, Manfaloot, Egypt, dental index unknown; skull will be denuded and measured.
Mesodont, American Negro, dental index between 42 and 44. (Specimen not yet selected.)
Megadont, native woman, northwest coast of Australia, dental index 47.7.

VIII. Series Illustrating Variations Due to Development of Muscles of Mastication.

Shortest distance between temporal ridge and sagittal suture 65 millimeters, European man.

Shortest distance between temporal ridge and sagittal suture 46 millimeters, Papuan man, New Ireland.
Width of ascending ramus of jaw 30.5 millimeters, European man.
Width of ascending ramus of jaw 38.5 millimeters, Maori man, Chatham Islands, New Zealand.
Outward everted angle of jaw.
Inward everted angle of jaw.
Comparison of angle of jaw of infant, adult, and edentulous individuals.
Parallelism of borders of ramus, jaw of Mound-builder.
Lack of parallelism of borders of ramus, jaw of European man.

IX. Comparison of Symphysian Angle.

Angle acute (69°), jaw of American White.
Angle obtuse (98°), jaw of Australian.

X. Position of Inferior Third Molar.

Third molar in front of anterior border of coronoid process, jaw of American aborigine, coast of California.
Third molar behind the anterior border of the coronoid process, jaw of European.

XI. Series of Skulls Sectioned to show Nasal Fossæ and Accessory Sinuses.

Nasal fossæ, vertically bisected skull.
Frontal sinus, sectioned on skull.
Ethmoidal sinuses, sectioned on skull.
Sphenoidal sinus, sectioned on skull.
Maxillary sinuses, sectioned on skull.

XII. Series of Abnormal Teeth.

This comprises a limited number of specimens, each mounted on an individual standard and labeled.

COLLECTION ILLUSTRATING COMPARATIVE ODONTOLOGY.

The classification of the individual specimens composing this collection is strictly odontological, the larger portion of each label being devoted to dentition, series and type of molars, if any, comparison of superior and inferior dental arches, the dental formula, and the individual peculiarities of the type under consideration; while a separate and subordinate division of the label takes up the zoological classification from class to species, together with the geological distribution and, in fossil forms, the geological horizon.

Invertebrate Section.

The propriety of including the masticatory apparatus of invertebrates in an odontological collection depends largely upon our definition of teeth. If by these are understood "certain hard bodies situated in the mouth or at the beginning of the alimentary canal," then the buccal armament of the higher invertebrates comes within our province, although in none are they strictly homologous to the teeth of vertebrates. The following selection illustrates the more important types of mouth-parts found in the higher classes of this great natural division.

Echinodermata, Aristotle's lantern or sea-urchin, *Stongylocentrotus franciscanus.*

Vermes, Nereis with chitinous tooth-parts, *Nereis virens* (jaws only).

Mollusca, radula of a carnivorous Gasteropod, *Fulgur carica*; beak of a Cephalopod (cuttle-fish), *Sepia fillouxi.*

Crustacea, stomach-lining with gastric teeth of lobster, *Homarus americanus.*

Arachnoidea, foot-jaws and mouth-parts of horse-shoe crab, *Limulus polyphemus.*

Insecta, dragon-fly with mouth-parts, *Aeschua constricta.*

Vertebrate Section—Fishes.

Under this name are grouped several classes of fish-like animals, two of which, the Elasmobranches and Pisces, are represented in this collection.

The teeth of fishes, although exceedingly diversified, represent a primitive type, a point that is accentuated by the indefinite multiplication of them in many fishes.

Of their development, Gagenbaur says the teeth of the maxillaries "appear as differentiations of a homogeneous, primitive dental garniture coming from the external tegument and continued in the buccal cavity."

In the Selachians the morphological homology between teeth and scales is the closest, as both are derived from the calcification of simple papillæ of the skin. In other fish the teeth are developed as in other vertebrates, from three separate cellular layers by dental capsules sunk more or less profoundly in the skin.

They may cover all the osseous and cartilaginous parts of the buccal cavity and also the branchial arches.

Their variety and form is extraordinarily great, and frequently so changeable with age, sex, and their position in the buccal cavity that isolated teeth cannot always be determined with certainty.

From the minute filiform teeth of many fishes to the huge pavement-teeth of others, we pass through every gradation of form. In numbers they vary from one to many hundreds.

The fixation on the bones or cartilages in the young age is by ligaments, often permitting a certain mobility which persists through life in some groups, while in others, particularly the Ganoids and Teleosts, in a later stage of development there occurs a complete soldering of the tooth to an osseous pedicle formed from the underlying bone. Rarely the teeth are in sockets or alveoli.

Replacement is usually effected by a progression toward the exterior, during which the osseous pedicles are absorbed. Only in certain fishes with very large pavement-teeth is there no succession.

Notwithstanding the extraordinary polymorphism, their structure is quite uniform.

Class Elasmobranchii.

Order Squali.—Family Ginglymostomatidæ. Ginglymostoma cirratuma (Nurse Shark), warmer parts of Atlantic.

Family Lamnidæ. Carcharodon megalodon (Tertiary), phosphate beds of South Carolina, three teeth; Carcharodon megalodon (Tertiary), phosphate beds of South Carolina, tooth.

Family Cestracionidæ. Acrodus anningiæ (Jurassic), Lyme Regis, England, cast of teeth of lower jaw. Ptychodus polygyrus (Cretaceous), Kent, England, tooth. Cestracion phillipsi (Port Jackson Shark), Australia.

Order Raiæ.—Family Myliobtidæ. Ætobatis narinari (Bishop Ray), Virginia to Indian Ocean.

Family Pristidæ. Pristis sp. (Saw-fish), tropical and sub-tropical seas.

Class Pisces.

Order Selachostomi.—Family Polydontidæ. Polyodon spathula (Paddle Fish, Spoon-bill Cat), Mississippi water shed.

Order Ganoidei.—Family Sirenidæ. Ceratodus sp. (Trias), Wurtemburg,

casts of two teeth. Ceratodus sp. (Barracuda, Lung Fish), fresh waters of Queensland, Australia.

Family Lepidosteidæ. Lepidosteus osseus (Gar Pike, Bill Fish), Great lakes and rivers from Vermont to Rio Grande.

Order Physostomi.—Family Esocidæ. Esox lucius (Pike), fresh waters of Europe, Asia, and North America.

Order Acanthopteri.—Family Xiphidæ. Xiphus gladius (Swordfish), Atlantic and Pacific.

Family Carangidæ. Selene sp. (Moonfish), tropical Atlantic.

Family Potomadæ. Pomatomus saltator (Bluefish), Atlantic.

Family Serranidæ. Serranus sp. (Sea Bass), Atlantic.

Family Labidæ. Scarus sp. (Parrot-fish), tropical Atlantic.

Family Chætodontidæ. Holacanthus ciliaris (Angel-fish), West Indies.

Family Blenniidæ. Anarrhichas lupus (Wolf-fish), North Atlantic.

Family Gadidæ. Gadus morrhua (Cod), from 50 to 75 degrees, North Atlantic.

Order Pediculati.—Family Lophiidæ. Lophius piscatorius (Angler, Fishing Frog), northern parts of Atlantic coasts of Europe and America.

Order Plectognathi.—Family Balistidæ. Monacanthus sp., tropical Atlantic.

Family Tetrodontidæ. Chilomycterus sp. (Rabbit Fish), tropical Atlantic.

Class Batrachia.

The teeth are conical, pointed, usually simple, generally found on the intermaxillaries, superior and inferior maxillaries, vomers, palatines, and sometimes on the parasphenoids and pterygoids.

Only in the Anouras do we find some edentulous forms (toads), and others with teeth restricted to the upper jaw (frogs). Commonly the teeth are present in large numbers, arranged in a single row, except upon the vomers, parasphenoids, and pterygoids, where numerous rows, ribbons, or patches of teeth may be found, which are much smaller than the maxillary teeth.

They usually slightly decrease in size toward the front and back of the jaws, but in the Stegocephales there are larger tusks in the symphyseal region.

Succession is generally effected, not as commonly in the reptiles by a vertical succession, but by a tooth formed at the side of the existing one, which, before the absorption of its base and of the osseous apophysis upon which it stands, gradually moves into its place. In the Stegocephales the young tooth is formed in the shallow alveolus left by a shed tooth.

In living amphibians only the point of the tooth pierces the mucous membrane, and is, as a rule, covered with enamel, which rapidly decreases in thickness toward the base and insensibly disappears.

The principal part of the tooth is formed of dentin. In modern batrachians the base is composed of cement, and is distinguished from the dentin by the absence of canals as well as by the presence of isolated cartilaginous corpuscles.

Teeth of batrachians are distinguished from those of fishes principally by the absence of vaso-dentin, their pulp-cavities being filled by cellular connective tissue and the cavities formed remaining empty. The teeth of the Stegocephali are frequently distinguished by the strong plications of the dentin and a labyrinthiform structure recalling that of certain paleozoic ganoid fishes.

Order Urodela.—Family Proteidæ. Necturus lateralis (Menobranchus, Mud Puppy), Eastern United States.

Family Menopomidæ. Menopoma alleghaniensis (Hell-Bender), Mississippi Valley.

Family Protonopsidæ. Sieboldia maxima (Giant Salamander), Japan.

Order Anura.—Family Ranidæ. Rana mugiens (Bull Frog), Eastern United States.

Family Bufonidæ. Bufo lentiginosus (Toad), United States.

Class Reptilia.

In the number, mode of attachment, and location of the teeth of this class we find great diversity, but comparatively little variety in their form.

The teeth of reptiles are not differentiated into incisors, canines, and molars. Their roots are generally simple, and ordinarily the crowns have but a single point. They may be attached by their bases directly to the jaw or raised upon special bony pedicles (acrodont); ankylosed by their sides to ridges or to the sides of sockets in the bone (pleurodont), or they may remain unattached in grooves or in sockets (thecodont).

Sometimes the palatines and pterygoids bear teeth as well as the premaxillaries and superior and inferior maxillaries (to which are confined the teeth of mammals).

In composition they are similar to those of mammals, but in structure frequently exhibit great modifications.

Order Ichthyopterygia.—Family Icthyosauria. Ichthyosaurus sp., fossil skull, Jurassic, England.

Order Sauropterygia.—Family Nothosauridæ. Nothosaurus mirabilis, cast of skull, Trias, Bavaria.

Family Plesiosauridæ. Pliosaurus macromerus, fossil tooth, Jurassic, England.

Order Chelonia.—Family Cheloniidæ. Thalassochelys caouna (Loggerhead Turtle), Atlantic Ocean.

Order Theromorpha.—Family Dicynodontia. Dicynodon lacerticeps, cast of skull and jaw, Trias, Cape Colony.

Family Placodontidæ. Placodus gigas, cast of palate, Trias, Bavaria.

Order Rhyncocephalia.—Family Rhyncocephalina. Hatteria punctata (Sphenodon), New Zealand.

Order Lepidosauria.—Family Varanidæ. Varanus niloticus (Monitor), Egypt.

Family Mososauridæ. Mososaurus camperi, cast of lower jaw, Cretaceous, Holland.

Family Pythonidæ. Python, Old World.

Family Crotalidæ. Crotalus adamanteus (Diamond Rattler), Southern United States.

Order Crocodilia.—Family Alligatoridæ. Alligator mississippiensis (Alligator), Southern United States.

Family Crocodilia. Crocodilus vulgaris (Nile Crocodile), mummied head, Manfaloot, Egypt.

Order Dinosauria.—Family Megalosauridæ. Megalosaurus bucklandi, cast of upper jaw, Jurassic, England.

Class Aves.

Birds of modern times are toothless, the bones of the jaws being incased in horny sheaths, which, in some cases at least, are developed from a series of vascular pulps ranged along the jaws, and which suggest dental pulps.

These sheaths or beaks may have simply denticulate or serrated edges, and within the mouth there may be various rugosities for prehension or for sifting the mud and water from which the food is obtained. Commonly these modifications of the surfaces are confined to the horny beaks themselves, but they may extend to the bone; thus, in the Merganser, the tooth-like serrations of the beaks rest upon corresponding prominences in the bones of the jaws.

Birds of ancient times were provided with teeth. We are now acquainted with a number of species belonging to the three sub-classes, Saururæ,

Odontotormæ, and Odontoholcæ, in which teeth were present either implanted in distinct sockets or in a common canal, as in the Ichthyosaurus.

Sub-Class Odontoholcæ.

Order Dromæopappi.—Hesperornis regalis, two casts of portions of mandibles, Cretaceous, Kansas.

Order Tubinaries.—Family Diomedidæ. Diomeda exulans (Albatross), Sub-Antarctic region.

Family Procellariidæ. Ossifraga gigantea (Giant Fulmar), South Atlantic.

Order Steganopodes.—Family Pelecanidæ. Pelecanus fucus (Brown Pelican), North and Central America.

Order Anseres.—Family Anatidæ. Cygnus olor (Swan), Palæarctic Europe.

Order Herodiones.—Family Plataleidæ. Ajaja rosea (Roseate Spoonbill), Florida and Southward.

Family Ciconiidæ. Ciconia alba (Stork), Africa.

Order Accipitres.—Family Vulturidæ. Sarcorhamphus gryphus (Condor), Andes.

Order Pstittaci.—Family Conuridæ. Macrocercus aracauga (Macaw), Tropical America.

Order Pici.—Family Picidæ. Campephilus pileatus (Pileated Woodpecker), Northern United States.

Order Picariæ.—Family Eupupidæ. Eupupa epops (Hoopoe), warmer parts of Old World.

MAMMALIA.

It is in the Mammalia that the teeth attain their greatest complexity and differentiation.

Of a simple homodont and (generally) monophyodont type in the lower orders, the vast majority of mammals possess a heterodont, diphyodont dentition, with teeth modified in accordance with their dietary requirements, and in many cases, among males, with enlargement of the canines for sexual warfare. In all mammals the teeth are confined to the premaxillæ and superior maxillæ in the upper jaw, and to the inferior maxilla below. They are inserted, with few exceptions, in distinct sockets, to which they do not become ankylosed. As a rule the cheek-teeth have two or more roots,—a feature not found in any other class. Although the implantation is solely thecodont, the types of teeth presented by the various orders range from the simple conical haplodont type through every variety of ptychodont, bunodont, secodont, and lophodont types. As, with rare exceptions, all mammals have a definite number of teeth, characteristic of a given genus or species, the dental formula thereby rendered possible forms a valuable diagnostic feature in the identification of species.

Our knowledge of the steps in the evolution of the more complex forms has been so greatly extended in recent years through the discoveries made by American paleontologists in the tertiary and quaternary strata of our Western States, that no collection of odontology worthy the name could be made which should fail to embrace those extinct ancestral types of living orders, whose introduction to science has rendered imperishable the names of Leidy, Cope, Marsh, and others.

As evolution has left its most varied record on the molars,—a type of tooth peculiar to mammals,—it follows that these links in the chain of evidence have received vastly more investigation than have the dentures of other classes, and a nomenclature has arisen at once concise, convenient, and descriptive, with which to record these varied forms. This nomenclature has been followed in the labeling of the accompanying series.

Sub-Class Ornithodelphia.

Order Monotremata.—Family Ornithorhynchidæ. Ornithorhynchus anatinus (Platypus Duck-Bill), South Australia.

Sub-Class Didelphia.

Order Marsupialia.—Sub-Order Diprotodontia.—Family Diprotodontidæ. Diprotodon australis, Quaternary, Darling Downs, Australia, cast of skull. Macropus giganteus (Giant Kangaroo), Australia.

Family Phalangeridæ. Phascolartos cinereus (Koala, Monkey Bear), Victoria, Australia. Petaurus australis (Yellow-bellied Flying Phalanger), Australia. Phalanger vulpina (Phalanger, Cuscus), East Indian Archipelago.

Family Phascolomyidæ. Phascolomys ursinus (Wombat), adult and young, New South Wales, Australia.

Family Peramelidæ. Perameles nasuta (Bandicoot), Australia.

Family Dasyuridæ. Sarcophilus ursinus (Devil), Tasmania. Dasyurus maculatus (Spotted-tail Dasyure), Tasmania.

Family Didelphyidæ. Didelphys Virginiana (Opossum), Georgia. Didelphys murinus (Mouse Opossum), Central America.

Sub-Class Monodelphia.

Order Edentata.—Sub-Order Tubulidentata.—Family Orycteropodidæ. Orycteropus afra (Aard Vark), South Africa.

Sub-Order Squamata.—Family Manidæ. Manis tricuspis (White-bellied Pangolin), West Africa.

Sub-Order Loricata.—Family Glyptodontidæ. Glyptodon reticulatus, cast of skull, Quaternary, Montevideo.

Family Dasypodidæ. Tatusia novemcincta (Peba), Mexico. Dasypus sexcinctus (Encoubert), Paraguay. Dasypus minutus (Pichy), La Plata.

Sub-Order Pilosa.—Family Myrmecophagidæ. Tamandua longicaudata (Tamandua Ant-eater), Brazil.

Family Megatheriidæ. Megatherium americanum, cast of skull, Quaternary, Argentine.

Family Bradypodidæ. Choloepus hoffmanni (Two-toed Sloth), Costa Rica.

Order Sirenia.—Family Halicoridæ. Halicore australis (Dugong), Australia.

Order Cetacea.—Family Delphinidæ. Delphinus delphis (Dolphin), Atlantic. Globicephalus melas (Pilot Whale), Faroe Islands. Monodon monoceros (Narwhal), tusk, Arctic Ocean.

Sub-Order Odontoceti.—Family Squalidontidæ. Squalodon grateloupi, cast of skull, Tertiary, France.

Family Physeteridæ. Mesoplodon, cast of jaws. Physeter macrocephalus (Sperm Whale), lower jaw, tropic seas.

Sub-Order Archæoceti.—Family Zeuglodontidæ. Zeuglodon hydrarchus (Tertiary), cast of skull, Claiborne, Ala. Zeuglodon cetoides, casts of teeth, Tertiary, Alabama.

Sub-Order Mystacoceti.—Family Balænidæ. Balæna sp., Whale-bone Whale, cast of head, Pacific.

Order Ungulata.—Sub-Order Toxodontia.—Family Toxodontidæ. Toxodon, cast of fossil skull, Quaternary, Buenos Aires.

Sub-Order Amblypoda.—Family Uintatheriidæ. Dinoceras mirabile, cast of fossil skull, Tertiary, Wyoming, United States. Dinoceras laticeps, cast of fossil jaw, Tertiary, Wyoming.

Sub-Order Proboscidiæ.—Family Dinotheriidae. Dinotherium giganteum, cast of fossil skull, Tertiary, Epplesheim, Rhine Valley.

Family Elephantidæ.—Mastodon americanus, cast of fossil jaw, Quaternary, Hooperstown, Ill.

Mastodon americanus, two right molars and portion of tusk, Quaternary, Indiana.

Mastodon americanus, R. sup. molar in jaw, Quaternary, Citra, Fla.

Mastodon americanus, molar, Quaternary, Indiana.

Mastodon americanus, milk molar, Quaternary, Indiana.

Mastodon longirostris, cast of molar, Tertiary, Lyons, France.

Elephas primigenius, section of tusk, Quaternary, Siberia.

Elephas primigenius, molar, Quaternary, Cincinnati, Ohio.

Elephas columbi, skull and lower jaw, Quaternary, Observatory Point, Miss.

Elephas columbi, molar, Quaternary, Lane Co., Kansas.

Elephas africanus, African elephant, Equatorial Africa.

Sub-Order Hyracoidea.—Family Hyracidæ. Hyrax capensis, Coney, South Africa.

Sub-Order Perissodactyla.—Family Titanothriidæ. Brontotherium, skull and jaw, Tertiary, South Dakota.

Family Rhinocerotidæ.—Hyracodon nebrascensis, palatal region and lower jaw, Tertiary, Black Hills, South Dakota.

Cœlodonta antiquitatis, cast of two superior molars, Quaternary, France.

Rhinoceros occidentalis, portion of upper jaws, Tertiary, Bad Lands, South Dakota.

Rhinoceros occidentalis, left ramus of jaw, Tertiary, South Dakota.

Rhinoceros simus (Burchell's Rhinoceros), Africa.

Family Equidæ.—Equus caballus (Horse), United States.

Hipparion gracile, one right inferior premolar, two left superior molars, two left inferior molars, Tertiary, Greece.

Family Palæotheriidæ.—Palæotherium crassum, cast of head, Tertiary, Montmarte, Paris.

Anchitherium bairidi, cast of skull and jaw, Tertiary, Nebraska.

Family Lophodontidæ.—Hyracotherium leporinum, cast of skull and jaw, Tertiary, England.

Family Tapiridæ.—Tapirus arvensis, cast of palate and lower jaw, Tertiary, Auvergne, France.

Tapirus bairdi (Tapir), Nicaragua.

Sub-Order Artiodactyla.—Family Bovidæ. Bison americanus (Buffalo), Nebraska.

Ovis canadensis (Mountain Sheep), Montana.

Capra ægagrus (Goat), E. Europe.

Gazella bennetii (Steinbuck), Africa.

Family Cervidæ.—Alces malchis (Elk, Moose), N. Europe.

Moschus moschiferus (Musk Deer), Central Asia.

Family Tragulidæ.—Tragulus javanicus (Chevrotain), Malay Peninsula.

Family Camelidæ.—Auchenia pacos (Alpaca), Peru. Camelus arabicus (Dromedary), Egypt.

Family Anoplotheriidæ. Anoplotherium commune, cast of skull and jaw, Tertiary, Paris, France.

Family Oreodontidæ.—Oreodon culbertsoni, skull and lower jaw, three series of superior molars showing various stages of wear, Tertiary, Chadron, Nebraska.

Family Anthracotheriidæ.—Anthracotherium magnum, cast of lower jaw, Tertiary, Auvergne, France.

Family Chœropotamidæ.—Elotherium magnum, cast of jaw, Tertiary, Southern France. Elotherium mortoni, palatal region, Tertiary, Chadron, Nebraska.

Family Dicotylidæ.—Dicotyles tajacu (Collared Peccary), Arkansas.

Family Suidæ.—Phacochœrus œthiopicus (Wart-Hog), S. E. Africa.

Sus barbatus (Wild Boar), Borneo. Sus scrofa domestica (Common Hog), Chicago.

Family Hippopotamidæ.—Hippopotamus sivalensis, cast of skull and jaw, Tertiary, Siwalik Hills, India. Hippopotamus amphibius (Hippopotamus), Africa.

Order Rodentia.—Family Leporidæ. Lepus timidus (Common Hare), Spitzbergen. Lepus sylvaticus (Gray Rabbit), North America. Lepus trowbridgei (Trowbridge's Hare), California.

Sub-Order Simplicidentata.—Family Caviidæ. Hydrochœrus capybara (Capybara), South America.

Family Dasyproctidæ.—Cœlogenys Paca (Sooty Paca), Paraguay.

Family Castoroididæ.—Castoroides ohioensis, cast of fossil skull, Quaternary, Clyde, N. Y.

Family Chinchillidæ.—Lagostomus trichodatylus (Viscacha), Pampas of South America.

Family Hystricidæ.—Erethizon dorsatus (Canada Porcupine), Canada. Atherusa faciculata (Brush-tailed Porcupine), Borneo. Hystrix cristata (Common Porcupine), Algiers.

Family Octodontidæ.—Aulacodus swinderianus (Ground Rat), South Africa.

Family Dipodidæ.—Dipus ægyptiacus (Jerboa), North Africa.

Family Geomyidæ.—Geomys bursarius (Pocket-Gopher), Iowa.

Family Spalacidæ.—Spalax typhlus (Mole Rat), Norway.

Family Muridæ.—Fiber zibethicus (Muskrat), North America. Myodes lemmus (Lemming), Norway. Neotoma cinera (Wood Rat), North America. Cricetus frumentarius (Hamster), North Asia. Phlœmys cumininghi, Philippine Islands. Gerbillus indicus, India. Hydromys chrysogaster (Golden-bellied Water Rat), Australia.

Family Castoridæ.—Castor canadensis (Beaver), Canada.

Family Sciuridæ.—Arctomys monax (Woodchuck), Eastern Nova Scotia. Pteromys inornata (Flying Squirrel), Kashmir, India. Sciurus niger ludovicianus (Western Fox Squirrel), Western United States.

Order Carnivora.—Sub-Order Pinnipedia.—Family Phocidæ. Phoca grœnlandica (Harp Seal), Baffins Bay. Halichoerus grypus (Gray Seal), Norway. Ogmorhinus leptonyx (Sea Leopard), Australia.

Family Trichechidæ. Trichechus rosmarus (Atlantic Walrus), Arctic Ocean.

Sub-Order Fissipedia.—Family Mustelidæ. Gulo luscus (Wolverine), Canada. Mustela putorius (Common Polecat), Germany. Mustela pennanti (Fisher Marten), Maine. Ictonyx zorilla (Cape Polecat), South Africa. Taxidea americana (American Badger), United States. Meles vulgaris (European Badger), Europe. Mephitis mephitica (Skunk), New York. Latax lutris (Sea Otter), North Pacific. Lutra vulgaris (European Otter), Sweden.

Family Procyonidæ. Cercoleptes caudivolvulus (Kinkajou), South America. Procyon cancrivorus (Crab-eating Raccoon), South America.

Family Ursidæ. Ursus americanus (Black Bear), North America. Ursus maritimus (Polar Bear), Arctic regions.

Family Canidæ. Canis macrourus (Long-tailed Fox), Western United States. Canis lagopus (Arctic Fox), Northern North America. Canis fulvus (Red Fox), North America. Canis virginiana (Gray Fox), Colorado. Canis latrans (Coyote and young), Western United States. Canis occidentalis (American Wolf), Nebraska. Canis familiaris (Domestic Dog), New York.

Family Hyænidæ. Hyæna striata (Striped Hyena), North Africa.

Family Proteleidæ. Proteles lalandii (Aard Wolf), South Africa.

Family Viverridæ. Herpestes pluto (Ichneumon), Liberia.

Family Felidæ. Machærodus neogæus (Saber-toothed Tiger), cast of skull, Quaternary, Brazil. Felis concolor (Puma), Colorado. Felis rufa (American Wild Cat), Nebraska. Felis viverrina (Flat-head Cat), Borneo. Felis domestica (Common Cat, adult), New York. Felis domestica (Common Cat, young), New York. Felis leo (African Lion), Africa.

Order Insectivora.—Sub-Order Dermoptera.—Family Galeopithecæ. Galeopithecus volans (Colugo), Borneo.

Sub-Order Insectivora Vera.—Family Tupaiidæ. Tupaia tana (Tree Shrew), Borneo.

Family Erinaceidæ. Erinaceus europæus (Hedgehog).

Family Talpidæ. Scapanus breweri (Hairy-tailed Mole), Eastern United States.

Family Centetidæ. Centetes ecaudatus (Tenrec), Madagascar.

Order Chiroptera.—Sub-Order Microchieroptera.—Family Emballonuridæ. Cheiromeles torquatus (Collared Bat), Borneo.

Sub-Order Megachiroptera.—Family Pteropodidæ. Pteropus edwardsi (Flying Fox), India.

Order Primates.—Sub-Order Lemuroidea.—Family Lemuridæ. Lemur catta (Ring-tailed Lemur), Madagascar. Indris brevicaudata (Indris), Madagascar. Propithecus verreauxi, Madagascar.

Sub-Order Anthropoidea.—Family Hapalidæ. Hapale leucocephala (Marmoset), South America.

Family Cebidæ. Nyctopithecus felinus (Douroucoulis), South America. Cebus sp. (Capuchin Monkey), South America. Pithecia satanas (Brown Cuxio), Brazil. Ateles sp. (Spider Monkey), South America. Mycetes palliatus (Howler), South America.

Family Cercopithecidæ. Mesopithecus pentelici (fossil), Tertiary, Pikermi, Greece. Semnopithecus sp. (Indian Langur), Southeast Asia. Colobus ferruginea (Guereza), West Africa. Cynocephalus maimon (Mandrill), West Africa. Cynocephalus porcarius (Chacma Baboon), South Africa.

Family Simiidæ. Dryopithecus fontani (fossil), Tertiary, St. Gaudens, France. Simia satyrus (Orang-utan, adult), Borneo. Simia satyrus (Orang-utan, young), Borneo. Gorilla savagei (Gorilla, male), Western Equatorial Africa.

Family Hominidæ. Homo sapiens (Man), Vienna, Austria.

SERIES ILLUSTRATING CLASSIFICATION OF MOLARS.

Haplodont.—Series (a), Trichechus (Walrus). (b), Orca (Killer Whale). (c), Choloepus (Sloth).

Ptychodont.—Series (a), Castor (Beaver). (b), Lepus (Rabbit).

Bunodont.—Series (a), Dicotyles (Peccary). (b), Phacochærus (Wart Hog).

Secodont.—(a) Sectorial, Felis (Tiger). (b) Tubercles few, alternate, trenchant, Canis (Fox).

Lophodont (Antiodont).—Maxillary series.—Selenodont, Equus (Horse). Tapirodont, Rhinoceros (Rhinoceros). Trichecodont, Manatus (Manatee).

Mandibular series.—Selenodont, Cervus (Elk). Hyracodont, Rhinoceros (Rhinoceros). Trichecodont, Manatus (Manatee).

Maxillary series (Amœbodont).—Symborodont, Titanotherium.

Mandibular series.—Symborodont, Titanotherium. Hippodont, Equus (Horse).

SERIES ILLUSTRATING DEVELOPMENT, SUCCESSION, IMPLANTATION, AND STRUCTURE.

Phascolomys ursinus (Wombat), skull and jaw sectioned to show implantation.

Cholœpus hoffmani (Two-toed Sloth), young skull showing eruption of teeth.

Physeter macrocephalus (Sperm Whale), longitudinal section of growing tooth; longitudinal section of adult tooth.

Balænoptera sp. (Fin-back Whale), several connected plates of baleen.

Balæna sp. (Right Whale), plate of baleen.

Sus scrofa (Domestic Hog), lower jaw sectioned to show implantation of tusks.

Elephas indicus (Indian Elephant), jaw sectioned to show developing tooth; transverse horizontal section of molar to show structure; longitudinal, vertical, and horizontal sections of molar to exhibit structure; longitudinal, vertical, and horizontal sections of molar showing peculiarities of deposition of cementum.

Elephas columbi (Fossil Elephant), longitudinal vertical section to show structure.

Elephas primigenius (Mammoth), transverse section of tusk.

Castor canadensis (Beaver), skull and jaw sectioned to show implantation.

Felis domestica (Cat), skull and jaw of kitten, sectioned, exhibiting the scarcely calcified germs of the permanent teeth.

Carcharodon megalodon (Fossil Shark), tooth longitudinally sectioned to show structure.

SECTION VII.—Continued.

Structural Development.

By C. N. PEIRCE, of the Section.

THE Chairman of the Section now under consideration has presented to you an array of landmarks rarely seen in a meeting or an association of professional individuals unless of a strictly scientific character. Each one of these representatives has a history, and from each one, the nearest akin, but more complex, has derived some organ, trait, or peculiarity essential to his being; and this is true from the most simple to the most complex, from the batrachian to man.

These traits or organs which are held in common, and uniting one species with another, are indicative of the road that has been traveled from the most immature or primitive to the most complex or highly specialized of the whole animal series.

Professor Barrett has endeavored to present, for your pleasure and instruction, representatives of the animal, or, more properly, the vertebrate series, and in this collection we have the elements of a study in comparative anatomy.

Dissimilar as these representatives are, when compared one with another on a superficial examination, we should find, on a careful and critical study of each, that they would pretty clearly demonstrate that the general plan of construction was a unit and that the divergencies were in response to the necessity of adaptation to environment, intensified by inheritance.

The development hypothesis maintains that all existing species have been derived from species of pre-existent geological periods as offspring or by direct descent; that there has been no total destruction of life in past times, but only a transfer of it from place to place, owing to changes of circumstances; that the types of structure become simpler and more similar to each other as we trace them from later to earlier periods, and that, finally, we

reach the simplest forms consistent with one or several parent types of the great divisions into which living beings are naturally distributed.

The evidences of derivation of species from species within the limits of the genus are abundant. It is not the extent and degree of difference that determines the definition of species from species, but it is the permanency of the characters in all cases and under all circumstances, and the certainty of these being transmitted to progeny.

Species may be either restricted or protean, the latter embracing many, the former few, variations. This is illustrated in the varieties in plumage and other peculiarities or characteristics in fowls, canaries, pigeons, ducks, hogs, cattle, and horses. If some of these intervening forms were destroyed, so as to leave a gap between definable groups of individuals, they would be very naturally designated as a species. That such variations and destructions have been going on from the beginning of life is now well recognized. It is a recognized fact, also, "that any change in the circumstances—that is, in the sum-total of influences affecting any organism—will be likely to work some alteration in that organism or its descendants, or in both." Chief among these external influences are: Food, soil, light, climate, attacks from enemies, either of its own or other species; also, cold, floods, and draught, all of which are factors in the struggle for existence.

A hasty glance of the several departments, commencing with the most simple, may not be out of place.

First. Protozoa (amœba, rhizopods): Animals which have neither a general body-cavity nor a nervous system.

Second. Polystomata (sponges, corals, etc.): Animals which have an internal cavity, and usually many inlets, with no parts or organs set aside for special purposes, but consisting of many cells.

Third. Cœlenterata (jelly-fish): Animals with a stomach-cavity, and a body-cavity extending out from this. The parts of the body are arranged regularly around a center, as the spokes of a wheel around the hub. They have a radiate symmetry.

Fourth. Echinodermata (star-fish, sea-urchins): Animals with a body-cavity separate from the stomach, a nervous system, and a system of water-tubes. These aid in locomotion. The symmetry approximately radiate.

Fifth. Vermes (worms, leeches): Animals which consist of two halves—bilateral symmetry—composed of a series of segments. Have no jointed limbs.

Sixth. Mollusca (shell fish, oysters, snails, etc.): Animals which have soft bodies, covered by a mantle. No jointed limbs. Something resembling a heart and blood-vessels forming a circulatory system. Often a shell outside the body, and a nervous system in which quite frequently there are not two equal or nearly equal sides to each part.

Seventh. Arthropoda (crab, spider, etc.): We have in these both carnivorous and herbivorous animals which have bodies made up of a series of joints, a symmetrical nervous system, some of which have a skeleton outside of the body, and jointed limbs.

Eighth. Vertebrates: The back-boned animals, which have a skeleton within the body, a brain, and a back-bone.

These are of five classes, as follows: Fishes, amphibians, reptiles, birds, and mammals.

The last, mammals, are the warm-blooded animals, which are largely represented in the various specimens exhibited by the Chairman of the Section, and in which we, as dentists, are largely interested because of the diversity of teeth which they present for our examination and study. They consist of sixteen orders, and may be named as follows:

1. Monotremes: Australian duck-bill.
2. Marsupials: Kangaroo, opossum, etc.
3. Edentates: Armadillo, ant-eater.
4. Sloths: An edentate and arboreal.
5. Sirens: Dugong, manatee, herbivorous mammal.
6. Ungulates: Horse, hog, deer.
7. Cetacea: Whales.
8. Pinnipeds: Seals.
9. Carnivores: Cat, dog, tiger, etc.
10. Hyracoids: Conies, pachyderm and arboreal.
11. Rodents: Rats, mice, rabbits.
12. Proboscides: Elephants.
13. Lemurs: Small, monkey-like, and arboreal.
14. Insectivores: Moles, hedgehogs, etc.
15. Cheiropters: Bats.
16. Primates: Monkeys, apes, man.

The teeth are of more interest to the dental profession than any other set of organs considered separately, and yet these organs, subserving nutrition, cannot be studied without a marked correspondence with other organs being noted, and to that extent is this true, that by one familiar with the science of paleontology, given the shape and structure of a tooth, the animal itself could almost be constructed, and, without doubt, its mode of progression, its food, and its habits of life could be quite fully portrayed.

A very interesting and suggestive query is, "Are the teeth, with other organs of living beings, adaptive or non-adaptive? Are they machines especially fitted to meet the demands of their environment, or are they not?"

Another not less interesting question is, "Did the occasion for its use follow the appearance of the structure, or did the need for the structure precede its appearance?"

The following answer to these questions, as given by the late Professor Cope, is certainly intelligible and rational: "Animals and plants are dependent for existence on their environment. It is an every-day experience that changes in environment occur without any preparation for them on the part of living things. If the changes are very great, death is the result. It is evident that the influence of environment is brought to bear on life as it is, or has been, and that special adaptations to it on their part must follow, not precede, changes of climate, topography, population, etc." Another very important consideration to add to this one is the well-known and recognized influence of use, motion, nutrition, not forgetting that pressure, impact, induced density. "The law of use and effort,"—*Kinetogenesis.* Structures are produced or established by animal movements.

No series of anatomical structures have proved of greater utility to the student endeavoring to indicate the exact relationship or history of mammalian forms than the teeth. He who attempts to master the subject is likely to be discouraged at the very threshold of his undertaking by the apparently very great diversity of tooth-forms with which he meets in the class mammalia. Dr. Wortman says, "If a little careful attention is bestowed upon the plan of organization of the teeth of certain groups, it is not difficult to discover that there are certain central or primitive types from which it is easy to derive other related forms of dentition

by simple addition, subtraction, or modification of parts already possessed." Teeth in the mammalia are defined as hard structures attached to the mucous surface of the oral or anterior extremity of the alimentary canal; their chief function is to subserve nutrition by the seizure and comminution of the food. Morphologically considered, however, they are specialized dermal appendages, characterized by the pressure of certain calcified material, giving them density and forming a material known as dentin, though to other epithelial or cuticular structures which are not so solidified, found in invertebrates and in a few lower forms of vertebrates, the term tooth has likewise been applied.

While they all subserve nutrition, and are, therefore, analogous in their function, their chief distinction consists in the fact, so far as known, that these latter consist of a corneous or horny substance, which is derived from the more superficial epidermal layer, and are, therefore, *ecderonic* in their origin. In the former, teeth of vertebrates, a papilla arises from the corium, and undergoes more or less calcification from its summit downward by a deposition in its substance of lime-salts, forming dentin. The dentin thus formed is a hard, elastic substance, consisting of closely-set tubuli, branching as they go, and whose crown may or may not be invested with an exceedingly hard (the hardest in the animal economy) and unyielding substance derived from the deeper layers of the epidermis, known as enamel. These are then *enderonic* in origin. Those of ecderonic origin are the so-called teeth of the annulosa or leech, the mollusca and insecta of the invertebrates, while the vertebrates with such teeth are represented by the teeth of the ornithorhynchus, palatal plates of the sirena, and the horny teeth of the lampreys, though if these structures are to be classed as teeth, can we exclude the *baleen* of the cetacea and the beaks of birds and reptiles? They certainly are analogous, so far as being an *oral armature*, and with similar function; but beyond this they have nothing in common with the teeth of enderonic origin, which in shape and function range from a simple cone, for seizing and retaining, to the incisors for cutting, cuspids or canines and carnivorous molars for tearing or lacerating, tuberculate teeth for crushing, and the complex grinding molar of the omnivorous and herbivorous for the trituration of food.

SECTION VII.—Continued.

A Case of Antral Disease Involving the Frontal Sinus.

By TRUMAN W. BROPHY, of the Section.

BY request of the Chairman of this Section, I have, since coming to this meeting, prepared a report of a case which verifies the statements first made by Dr. M. H. Cryer, of Philadelphia, showing direct communication of the frontal sinus with the antrum of Highmore.

During the spring of 1896, a patient was brought to me by a physician, and on examination I found that the upper right bicuspid and molar teeth had been removed. A small opening had been made into the antrum. Irrigation was carried on by syringing the parts daily with the usual antiseptic solutions, but satisfactory progress in arresting the disease had not been made, and the patient was brought to me for diagnosis.

Exploration of the cavity by means of a silver probe revealed no diseased bone, and the treatment recommended was more extensive opening and more thorough drainage. The opening was increased to some extent, better drainage secured, the usual treatment employed for irrigation and cleanliness, and the patient seemed to improve under this treatment, suppuration being to a very great extent diminished, but not wholly arrested. The patient returned home, and was under treatment there for two or three months, when she returned in about the same condition in which she was when I first saw her. It was then that I decided to remove a greater portion of the anterior wall of the antrum, that I might make an ocular examination of the cavity and employ such treatment as the condition of the parts suggested. On opening the cavity I found a thickening of the mucous membrane,

and polypi upon its surfaces, beside a small piece of flexible rubber tubing, used for drainage, which had been lost in the cavity by the gentleman who had treated the case. The cavity was thoroughly curetted, packed with boracic gauze, and on the following day the gauze was removed, the cavity irrigated, and the surfaces carefully examined, with a view to discovering any diseased tissue that might possibly have remained. The cavity was packed daily for a period of about a week, when a hard rubber canula was made, retaining the full size of the opening. A flange was allowed to extend over upon the oral mucous membrane, thus preventing the canula from passing into the antrum. The pressure of the cheek held this canula in place. This prevented the closing of the opening by granulations, and enabled me to thoroughly irrigate the cavity and watch the process of repair.

The membranes of the antrum, under antiseptic cleanliness and stimulation, soon returned to their normal condition, but there was still an accumulation of pus at the upper nasal surface of the cavity. After the lapse of two or three months, under the most vigorous treatment that could be employed, with a view to arresting this suppuration (the effort being unsuccessful), I decided that the frontal sinus must be involved. Accordingly, in the presence of Professor Barrett and others interested, I performed an operation at the Presbyterian Hospital, opening the sinus, which I found was filled with pus. The anterior wall of the frontal sinus was removed, so as to expose the greater portion of the cavity to view. It was found to be denuded of membrane, and, on carrying the incision downward along the inner canthus of the eye, I was able to introduce a silver probe and carry it directly into the cavity of the antrum without obstruction. Having succeeded in doing this, water was forced into the frontal sinus, and readily found its way through into the antral cavity. Then, removing a portion of the nasal bone of the affected side, I found that pus also dribbled from the region of the ethmoid cells. These cells were curetted, some diseased bone removed, and the surface, together with the frontal sinus and antrum, thoroughly irrigated. The wound made for the opening of the frontal sinus was closed, a drainage-tube, or rather a tube for the purpose of introducing fluids for irrigation, was introduced, and the parts dressed with antiseptic gauze, thus completing the operation. Fluid, boracic

acid solution, was daily made use of for irrigating the parts, being introduced through the tube. Suppuration continued for a short time, but finally ceased. There is no suppuration of the parts at present, but there is still a thick, glairy mucus which occasionally comes from the nasal cavity, and which is formed, no doubt, upon the nasal mucous membrane. This case, in my judgment, had its origin from a dental alveolar abscess. The teeth affected were removed before the patient came to me. The antrum became involved, and the mucous membrane of the antrum being continuous with that of the infundibulum, frontal sinus, and ethmoid cells, this membrane became diseased, involving the cavities named.

It is scarcely necessary for me to state that cases of this character could not possibly be cured by the opening and treatment of the antral cavity alone. In the treatment of these cases, diseased bony tissue must be removed, the parts thoroughly irrigated two or three times a day with antiseptic solutions,—and there is none better than a solution of boracic acid,—and then, in the event of suppuration being difficult to arrest, the agent which, in the destruction of infectious material, now extensively employed, in Europe especially, which is not new to us, but which is most efficient in its action, nitrate of silver. It may be used in cases of this kind in a strength of about two per cent.

The feature of the case which the Chairman of the Section especially desired me to present was the anatomical relation of the frontal sinus, infundibulum, and antrum of Highmore.

SECTION VII.—Continued.

Continued Study of the Relations of the Frontal Sinus to the Antrum.

By THOMAS FILLEBROWN, of the Section

LAST year I made a report of some observations I had made on the formation of the infundibulum, showing that in many cases it continued directly to, and terminated in the foramen of, the antrum, and that a fold of mucous membrane mentioned by Merkle, in 1834, extended above the foramen, forming a pocket, from the bottom of which the opening into the antrum is situated, thus directing any discharge coming down the infundibulum into the antrum, so that, under ordinary circumstances, no abnormal discharge from the frontal sinus would escape into the nasal passage until the antrum was filled so as to cause a backward overflow.

I mentioned the fact that Tillaux, about 1840, noticed that of fluid injected into the frontal sinus a great part flowed into the antrum, and that Dr. Cryer, in 1895, mentioned the same circumstance. He also showed that a probe could be passed from the antrum into the frontal sinus. I also noticed that Bryan had mentioned the fact of occasional communications between the cavities, but considered them anomalies, and that Professor Harrison Allen had discussed the proliferation of empyema of the frontal sinus into the antrum. These observations were of isolated cases, and were not proven or considered indicative of the normal anatomy of the parts.

I reported that the examination of eight different subjects showed that the infundibulum continued as a deep groove, or tube, open on one side, down to the foramen of the antrum, and terminated in it, in every one of the eight cases, and that the

pocket described was present in seven of the eight. This seemed to imply that the continuation of the infundibulum to the antral foramen, and the presence of the pocket membrane, was the normal formation. During the past winter I had opportunity to examine fifteen heads in the Harvard dissecting-room, and found the infundibulum continuing to the foramen of the antrum in every case. The membranous fold was present in every case, except on the left side of one subject. In this case the process was broad and flattened toward the meatus, and, though the mucous fold was absent, the widened process served the same purpose, as it formed a cup-shaped cavity quite as capacious as the pocket on the other side.

In another case the mucous fold was thickened and had considerable muscular tissue intermingled in its substance.

On the right side of this subject the infundibulum was very large, and in place of the ordinary foramen there were two openings, both quite large, fully one-fourth of an inch in diameter.

In another case the pockets were large, irregular in form, and deep, the mucous fold completely covering the infundibulum from the foramen of the frontal sinus to the antrum.

In one subject the mucous fold was considerably calcified. This condition had obtained to a degree throughout the whole system. This subject was advanced in years. This makes a total of twenty-three cases, a number, I think, sufficient to establish the fact of the normality of the anatomy of the parts.

The very few variations only prove the rule. I hoped to secure the coöperation of others in making further examinations during the winter, but the reprints of my paper were too long delayed, and the dissecting season was passed before I could communicate with anatomists and make the necessary arrangements, and have the benefit of the results of examinations of other subjects.

SECTION VII.—Continued.

Human Teeth from a Comparative Standpoint.

VOLUNTARY PAPER BY CHARLES H. WARD.

MR. PRESIDENT AND GENTLEMEN: The collection illustrating Comparative Odontology, which I have the honor of exhibiting to the members of the American Dental Association, requires a body of specialists for its intelligent appreciation. Not alone is man represented by a wealth of material commensurate with the practical importance of the subject, but the entire range of the vertebrate sub-kingdom, both living and extinct, has been ransacked for types and specialized examples of dentition; while most of the higher groups of invertebrates, as well, have contributed their primitive masticatory organs.

Labeling.

An innovation for which I am responsible has been introduced in the labeling. Guided by that inspired definition of a scientific museum, "a series of explanatory labels illustrated by specimens," the present collection has been arranged both odontologically and zoologically, as in the following example:

Ward's Natural Science Establishment, Rochester, N. Y.

DENTITION, HETERODONT DIPHYODONT.

Molars { **Series**, Lophodont; **Type**, { Upper Selenodont (antiodont). Lower Hippodont (amœbodont). **Dental Arches**, Anisognathous.

Dental Formula, $i\frac{2}{3}$ $c\frac{1}{1}$ $pm\frac{4}{3}$ $m\frac{3}{3} = 42$.

Peculiarities: Incisors having the great peculiarity, not found in the teeth of any other living animal, of an involution of the external surface of the tooth, forming a deep pit, the bottom of which becomes partially filled with cement.

Class, Mammalia.
Order, Ungulata. **Sub-Order**, Perissodactyla.
Family, Equidae.
Genus and Species, Equus caballus.
Common Name, Horse.
Habitat: The entire civilized world.

The upper division of the card contains a concise record of the *type of dentition* (whether *homodont* or *heterodont*), of the *number* of *successional series (monophyodont, diphyodont,* or *polyphyodont).* Furthermore, among the heterodont mammalia, the molars are investigated as to series and type; the superior and inferior molars are compared as to whether alike in size and pattern (*isognathous*) or unlike (*anisognathous*). Finally, the *dental formula* and *total number of teeth* are noted, together with the more *salient peculiarities* of the denture in question.

Beneath all this, and separated by a line, a lower division presents the *systematic classification* of the animal described, beginning with the class and ending with the common name and habitat, or, in a fossil form, the locality in which found, with the *geological age* and *formation.*

The dental classification is founded on the works of Owen, Tomes (C. S.), Flower and Lydekker, Cope, Osborn, and others, and while in some groups hardly more than a provisional scheme, in our own class (mammalia) it rises to the dignity of a complex system, upon which orders are, in part, based and families, even genera, founded.

While engaged in the installation of this exhibit, curious visitors have frequently inquired, "Of what practical use is this collection to dentists?"

Truly, a vital question; the keystone upon whose stability depends a noble science.

Value of the Comparative Method.

Perhaps other fields of labor will suggest the answer. For example, among the niceties of microscopic technique, the "resolving" (Ang. *seeing*) of the minute markings upon certain diatoms is a time-honored test, both of objective and of observer. Now, to obtain a clear image of the markings of *Amphipleura pellucida,* or other diatoms of extreme delicacy of pattern, the light must be *obliquely* reflected upon the object. Of recent years disease, viewed by the *sidelight* of comparative pathology, is seen to be no demon of malevolent aspect, storming life's citadel, but ever Nature's vanguard, signaling the approach of unseen foes.

So, too, amid the dark corners of human anatomy,—and there are many, despite its two thousand years of exploration,—secrets of function, of variation, and of development await but the search-

light of the comparative anatomist, to stand revealed as the results of far-reaching and irrevocable laws, rather than the enigmas they now appear.

Atavism, that broader heredity by whose imperious edict characters derived from remote ancestral forms reappear in the human race as abnormalities, has discovered to the student the source of uncanny mysteries long deemed beyond human ken. Teratology, criminology,—aye, odontology,—owe much to this light.

Paleontology furnished the foundation for the boldest, the farthest-reaching, the most revolutionary theory ever formulated by the mind of man,—the doctrine of evolution. Surely, if the study of fossil forms could revolutionize within a decade the beliefs and conceptions of mankind, conceptions handed down unchallenged for more than twenty centuries; if this science could, for the first time in the history of our race, throw light on the development of life, of language, of civilization, of religion itself, it is at least probable that the systematic investigation of the comparative anatomy of the teeth must result in direct and valuable additions to human odontology, apart from the intellectual culture that inevitably follows devotion to science for its own sake.

Distribution of Teeth.

As a prelude to the more strictly human limits of my title, permit me to briefly outline that vast domain from whose farthest limits, we are told, our race has emerged through an exodus beside which that of the Israelites was but the footstep of an idle moment.

Teeth are by no means universal in the organic world, the entire vegetable kingdom, and many true animals as well, being devoid of them. The causes of this edentulous condition in forms whose existence depends upon the ingestion of food are various. Plants, with few exceptions, feed upon soluble, inorganic elements, that require merely to be absorbed,—by roots from the moist ground, by leaves from the surrounding air. There is no mouth, and therefore no teeth, in the plant.

Let us then turn to the animate world.

Ancient Marine Life.

Before the land was ready for the invasion of animal life, the shallow, wide-reaching oceans swarmed with living organisms.

The tiny protozoans, first voyagers of those primeval seas, have left a monument of their numerical greatness in the chalk-cliffs of England, a monument composed of the remains of Foraminifera so minute that a cubic inch of the chalk has been estimated to contain more than a million. Yet their fragile shells built up deposits, measuring in places a thousand feet in height, and extending from the north of Ireland to the Crimea. Beside this gigantic tomb the pyramids are but grains of sand; yet the pyramids themselves are built of Nummulitic limestone, a formation of great thickness, in some places *nearly two miles,* that stretches from France to China. The Nummulites (from which the rock derives its name), escaping from their matrix, have strewn the bases of the pyramids (and the plinth of Cleopatra's Needle, in Central Park, as well) with little round fossils, which Herodotus naïvely described as *fossil beans*, remains of the prehistoric meals of their forgotten builders. Now, these hundreds of leagues of strata contain, almost exclusively, not beans, but *Foraminifera.* As tending to modify our ofttimes too specialized conception of the parts necessary to an animal, it may be well to note that, of all that vanished host of amœboid organisms which "lived, and moved, and had their being" in those far-off geological epochs, not one possessed that apparently essential organ, a mouth!

Food of Protozoa.

The lot of the marine protozoan is, from the human standpoint, easy. Living in a fluid medium, its food is brought within its grasp in an already comminuted and macerated condition, the craggy coastline against which the troubled waters dash playing the part of teeth for myriads of fragile forms. And water, our universal solvent, by its softening and disintegrating processes, furthers this dissolution, producing in a simpler way the same result as do the most complex of digestive apparatuses,—namely, a solution.

Habits of Sponges and Cœlenterata.

Turning from these simple unicellular forms to the more complex Metazoa, we find the Sponges and Cœlenterata subsisting on water-borne rations, wafted into their body-cavities by scores of eager, waving arms. Living as they do in a sort of diluted broth, but little exertion is required to obtain food, and, accordingly,

whole communities of these lowly animals actually take root, in the comforting assurance that "all things come to him who waits." The progeny of these rooted forms are commonly born free swimmers; as for example, the young Sponge or Hydroid; but after a brief "grand tour" the former settles down, after the manner of his ancestors, while the latter, disdaining so tame an existence, yet begets offspring who, strangely enough, inherit their grandparents' form and habits with astonishing regularity.

Genesis of Locomotion.

The necessity of a proteid diet, however,—*i.e.*, of a food-supply consisting of the bodies of other organic beings, animal or vegetable,—eventually forced many animals into motion. Hunger was undoubtedly the genesis of locomotion, which latter is the price we pay for a proteid, and therefore scattered, diet. And all the myriad devices whereby the animal creeps or swims or flies,—the sperm-whale sweeping with pendulous mandible the floor of shallow oceans, the albatross poised on tireless pinions far above the rolling waves, the gorilla swinging lazily from branch to branch of tropic forests, the serpent gliding stealthily through the tremulous grasses,—all these diverse methods of transportation are the effect of food-supply. All higher animals possess this essentially ennobling attribute of voluntary motion, and it may be accepted as a truism that whenever a form, be it worm, fish, or man, attaches itself permanently to the food-supply as a parasite, that form degenerates.

Teeth Defined.

The propriety of including the varied masticatory mechanisms of invertebrates in an odontological collection can hardly be questioned. If by *teeth* we understand "certain hard bodies, situated in the mouth or at the beginning of the alimentary canal," as defined by Lucas,* then the buccal armament of the higher invertebrates falls within this category, although in none of these animals are they strictly homologous with the teeth of vertebrates.

Evolution of the Brain.

It is in that heterogeneous group of animals known collectively as Worms that these tooth-like organs first appear. Several

*Johnson's Encyclopedia, 1897, article "Teeth."

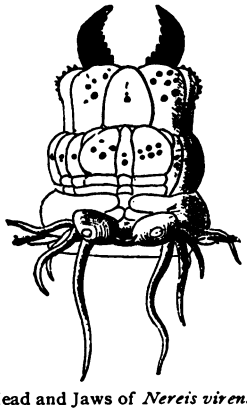
accompanying details of structure deserve passing mention. The fact that worms were the first multicellular animals to move habitually in one direction explains, as pointed out by Thomson, not only the development of a head, but, since the head-end must ever be the first to receive impressions of external objects, sensory organs and nerve-ganglia became more developed in this region.

An increase of this *cephalization* eventually produced the brain of higher types. As the olfactory organs, probably first developed as primitive food-inspectors, sharing in this centralization of the sensory apparatus, became located in the front rank of the great *nerve-sentinels*, it followed as a natural sequence that a mouth should be located in their immediate vicinity rather than elsewhere. Thus is explained the apparent anomaly of the existence, side by side, of the most material and the most ethereal of the bodily functions. Nereis, a common chætopod worm, has a pair of laterally opening jaws, each armed with a single sharp, horny hook, which, in the specimen exhibited, was dissected out.

Earliest Calcified Teeth.

The earliest appearance of calcified teeth is in a group of Echinoderms, popularly known as sea-urchins. Here we meet with that

FIG. 1.



Head and Jaws of *Nereis virens*.

FIG. 2.

Aristotle's Lantern of *Diadema setosum*.

complicated apparatus, the "Aristotle's lantern." It consists essentially of five jaws, each armed with a single socketed tooth, and is moved by an elaborate muscular system. This guards the

oral aperture and serves to comminute morsels too large to be swallowed whole. The jaws close somewhat after the manner of a drill-chuck, all the teeth moving concentrically; beside this, the whole apparatus may be protracted or retracted at will.

The habitual posture of the typical sea-urchin, mouth downward and anus uppermost, will doubtless strike the student of vertebrate morphology as anomalous.

Alimentary Organs of Arthropoda.

Among the Arthropoda (invertebrates with jointed appendages) the Crustacea offer interesting peculiarities of structure. In the crayfish or lobster, for example, mastication is accomplished in part by the hard, laterally moving mandibles, assisted by numerous modified feet; to be completed by the "gastric mill," located in the cardiac region of the stomach. During the annual moult, not only the external carapace, now grown too small, but the entire stomach-lining, ossicles and all, is cast off.

Obviously, there can be no edentulous senility in a creature yearly endowed with a complete new denture.

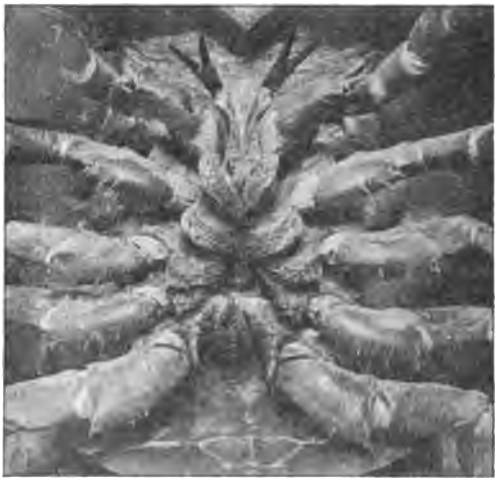
The specimen presented is the gastric mill of a lobster *(Homarus Americanus)*, who may haply yet contribute many duplicates to science ere his "salad-days" arrive.

Of the Myriapoda, those many-legged, worm-like forms, the poisonous Centipedes are armed with toothed, cutting mandibles, beside their two poison-claws. The similar, but harmless, Millipedes have mandibles modified for mastication. In no class do we find a greater variety of feeding-organs than in that of Insects. All, however, may be included within the masticatory and suctorial types, the one supplied with biting or cutting mandibles, the other frequently bearing, in addition to mandibles of reduced size, some form of lance-like appendage, together with a flexible, tubular proboscis, as in the common house-fly. The dragon-fly, or Devil's darning-needle of our boyhood, has the well-developed mandibles of the masticatory type. Surely, if any insect deserves well of mankind, it is this burnished knight, whose favorite food is *mosquitoes.*

In those insects which include a complete metamorphosis in their life-history the larval form is characterized by masticatory organs of exceptional size and vigor, which may be much reduced,

or even entirely modified in character, in the imago. Thus, the larval butterfly, who has been observed to eat many times his own weight of vegetable food in a single day, has cutting jaws of adequate proportions, while the adult is suctorial in habit. Indeed, among many insects, as the May-fly, or the butterfly of the silk-worm, the adult has undergone an atrophy of the digestive tube, contemporaneously with development of the reproductive organs. Having wholly ceased to feed, their subsequently brief maturity is devoted to love; to the generation of progeny upon which their parental eyes can never rest.

FIG. 3.



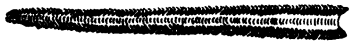
Ventral Surface of *Limulus polyphemus*, showing mouth-parts.

Of the Arachnoidea, all scorpions and spiders are suctorial feeders, although in both the prey is grasped by *falces,—i.e.*, jointed mouth-parts,—which in spiders contain poison-glands. In mites and ticks the mouth-parts may be modified either for biting and comminuting, or for piercing and sucking. Finally, that solitary survivor of a most ancient family of arachnoids, the king-crab (*Limulus polyphemus*), which is not a crab at all, wears his mouth between his five pairs of legs, the bases of which are toothed and assist in prehension and mastication.

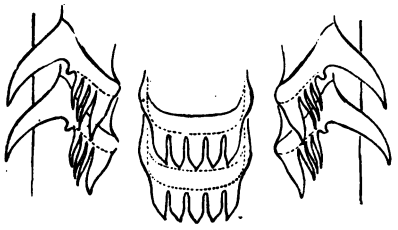
Teeth of Mollusca.

Of the three principal classes of Mollusca, two exhibit considerable variety of dentition, while the Lamellibranches, or bivalves, at once the lowliest and the least motile of the group, are devoid of hard mouth-parts. These headless forms ingest microscopic plants and animals and organic *débris*, which are swept into the mouth by the lashing cilia or throbbing gills. They are seemingly devoid of any power of selection, ingesting indifferently

FIG. 4.

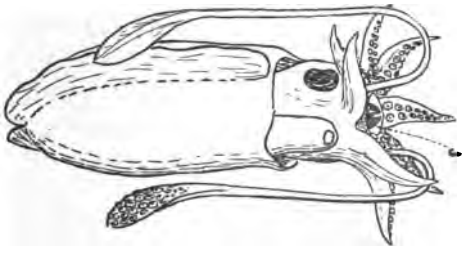


Radula of Winkle.



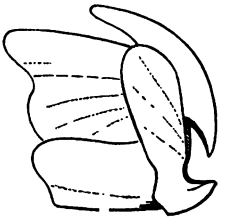
Two Rows of Teeth, enlarged.

FIG. 5.



Cuttle-fish, showing Beak.

FIG. 6.



Beak of Cuttle-fish.

such nutritious or innutritious particles as may come their way. The ciliated epithelium of the human palate and pharynx, in common with the branchial clefts of the embryo, are undoubtedly souvenirs of an earlier marine ancestor, from whom we, in common with all the terrestrial vertebrata, have sprung.

Indeed, who shall say that the intense, yet undefinable, charm that the ocean has for so many of us is not the awakening of an hereditary memory, a dim recognition of our long-deserted home?

And in this connection that subtle observation of Woods Hutchinson, that our tissues to-day are ninety-nine per cent. marine, living only while immersed in the blood-plasma, a saline solution, while the odd one per cent.,—the epidermal structure,—is dying from drought, is pregnant with meaning.

Among the ranks of the Lamellibranches are genera, as Lithodomus, whose works are shrouded in mystery. Certain it is that, without any apparent means, this singular bivalve excavates smooth, capacious holes in stone or coral reefs in which to dwell. He is, in fact, a cave-dweller who makes his own cave. Turning now to the higher mollusca, the *radula*, or lingual ribbon, a long, tongue-like body, thickly beset with rows of recurved, horny teeth, is common to both Gasteropods (snails and the like) and Cephalopods (cuttle-fish, squid, octopus, etc.), both of which classes have heads. It is used after the manner of a rasp.

The number of rows, the form and comparative size of these teeth, prove valuable data to the conchologist in the separation of the various genera of Gasteropods, since each genus possesses a fairly constant "lingual dentition." Teeth as a factor in classification are thus seen to immensely antedate not only mammalia, but all vertebrates whatsoever. A typical radula, that of the winkle (*Fulgur carica*), a carnivorous Gasteropod, is included in the collection and figured herewith. In addition to the radula, the Cephalopods, highest of mollusca, are armed with a horny beak, resembling that of a parrot, except that the upper mandible closes *within* the lower. The armed jaws are demanded by the ravenous carnivorous appetites of these terrible creatures. With one solitary exception (the nautilus) these jaws are horny. The specimen shown is the beak of a cuttle-fish *(Sepia fillouxi)*.

Effect of Increased Specialization.

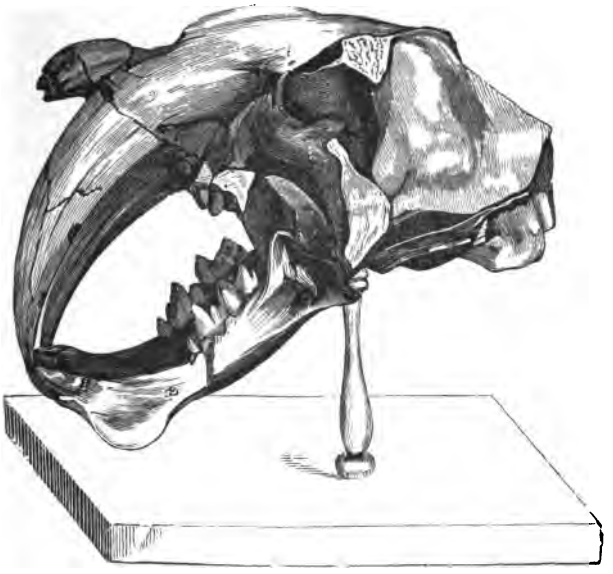
In this brief inspection of the typical groups of invertebrates with reference to their oral armament, one can hardly fail to observe that a gradual necessity for lacerating and comminuting organs arises as we advance along the line.

Whence springs this demand? What stimulus calls these parts into being?

As we rise in the scale of animal life, from the naked protoplasm of the amœba or monad toward the vertebrates, an ever-

growing complexity of *structure*, coupled with a sharper differentiation of function, is encountered. Division of labor is born. Not only are motor and sensory organs developed, and circulatory, nervous, alimentary, and reproductive systems elaborated, but various provisions for defense are added, so that it comes to pass that the animal who would feed upon one of these armored forms must be able not only to catch his prey, but to pierce its armor as well. The history of the struggle between the eater and

FIG. 7.



Saber-toothed Tiger.

the eaten has been imperishably recorded on bones and teeth. In one respect it singularly parallels the history of naval warfare. So long as the wooden frigate represented defense, the improvements in artillery were but trifling. When the first iron-clad (*invented* in America, *built* in France) was built, it was confidently believed to be impregnable. Yet within a comparatively brief period guns and projectiles powerful enough to pierce its armor-plating were invented, and for many years improvements in armor have been progressively nullified by corresponding improvements in armament and in explosives.

So, too, with animals. The mollusk no sooner secreted a shell than its enemy contrived a way to drill a hole in it, or a great fish developed pavement teeth wherewith to crush said mollusk, shell and all.

Among early mammals the Edentates were represented, not by the puny tribe of these latter days, but by gigantic forms, some with massive external armor (the armadillos); others with the thickest of skins and the burliest of bodies, as protection against their carnivorous enemies. (The Glyptodon, an extinct armadillo, and the Megatherium, a sloth, also extinct, represented in our collection, are of this group.) But a contemporary carnivore, stimulated, doubtless, as the late Dr. Newberry shrewdly suggested, by the necessity of piercing these huge bulks to a vital spot, specialized in the matter of canines, until presently his progeny were able successfully to cope with the giant Edentates of the South American pampas and the ponderous pachyderms of tertiary and quaternary Europe and Asia. The skull of that formidable cat known to science as *Machairodus neogaeus*, popularly as the saber-toothed tiger, presents the most remarkable example of extreme specialization in canines to be found in the entire range of the Fissipedia, or terrestrial carnivora, and excelled in the Pinnipedia only by the tusks of the walrus.

Vertebrate Animals.

Continuing our survey of the vertebrata, a certain similarity of structure may be traced, running through all the classes, a feature not observed among the invertebrates. Thus, they are nearly all bilaterally symmetrical (externally); they never bear more than two pairs of *paired* locomotor appendages; with the solitary exception of Amphioxus, all agree in the possession of a head, and all, without exception, have a vertebral column, either osseous or cartilaginous, or, represented by its rudimentary precursor, a notochord.

So, too, nearly all vertebrates agree in the possession of true teeth, either horny or calcified. The former are merely hypertrophied cells of the epidermis, surmounting long papillæ,—a sort of *oral corn*, developed as a protection against friction.

Cornified teeth are found in certain fishes and batrachians, and the permanent teeth of the Ornithorynchus—that bird-like, egg-

laying mammal—are of this type. Calcified teeth, however, are the rule among vertebrates. They are classed, with hair, feathers, scales, and scutes, as true dermal or enderonic appendages, being developed from the oral epithelium by a gradual permeation of the matrix, or tooth-germ, with lime-salts,—a sort of living fossilization.

Although very difficult to associate these hard, stony bodies with the soft, naked cuticle of man, the transition is easy if we approach the problem by the study of dental development in a less specialized and aberrant type.

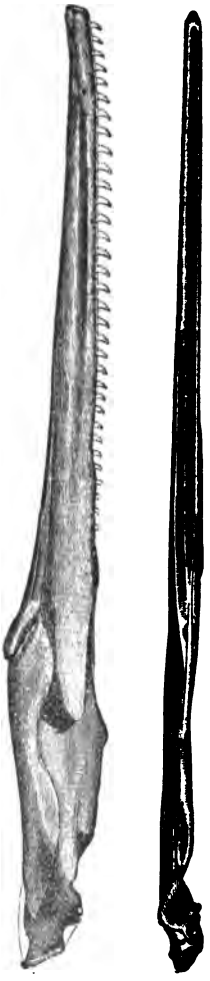
An Erroneous Point of View.

Our entire conception of anatomy is afflicted with mental strabismus, from our antique habit of using man as the *type* with which all other forms are compared, instead of wisely relegating him to his proper zoological position of a highly specialized and aberrant species,—in fact, a structural freak. Our anatomical treatises would read as strangely to the great majority of the mammalia as they would to us if written by an elephant, an animal, by the bye, whose structure approaches the human in many important particulars. The elephant would doubtless note that "most of the *lower* animals (the italics are mine), including that singular form, man, are distinguished by a ridiculously rudimentary nose and an atrophy of the superior median incisors. They are all degenerate in size, and exhibit a feverish activity incompatible with a contemplative and philosophical mind," etc. The average quadrupedal point of view would be far more nearly typical than our own. Thus, the nomenclature of the teeth in use in medical and dental schools is singularly ill adapted for general vertebrate description. Of our *incisors*, *cuspids*, *bicuspids*, and *molars*, two are grossly misleading; for, while a canine is always a cuspid, the converse is not true, the anterior premolars of many mammals being of this type, while *bicuspid* describes the *premolar* in but few orders other than primates.

But to "return to our mutton:" An invagination or pushing inward of the external skin is the first step in the formation of either the mouth or the anus of the vertebrate embryo. Now, as long ago observed in species whose external skin bears enamel-covered scales or denticles, as the sharks, the transition from

external scales to internal teeth is merely one of position and changing function, without modification of general form or method of attachment.

FIG. 8.



Left Lower Jaw of *Hesperornis regalis*, Marsh; one-half natural size; side view and top view.

Teeth of Elasmobranchii.

In sharks and rays the teeth are never fastened to the jaws, but remain anchored in a modified mucous membrane, the functional row in front, the numerous (five to seven) rows of growing teeth behind. These latter are brought into position by a gradual creeping forward of the tooth-bearing membrane over the underlying jaws. When a row gets too far forward, it drops out, the adjacent posterior row taking up the position and functions of its predecessor. Had some accident of evolution stimulated the psychic growth of the Elasmobranchii, as it did that of the primates, lifting them, instead of us, to mental preeminence, we can be assured that, to whatever stage of civilization they might have attained, no dentists would have arisen in the shark tribe. What a sinecure our Committee of Ethics would be, did the converse hold true!

The Dental Tissues.

Accustomed as we are to use the human animal as the type, it occasions some surprise to discover that the "three dental tissues," dentin, enamel, and cement, are by no means universally present in the teeth of vertebrates. Dentin alone is ever present; enamel is frequently lacking, as in many fishes, a few reptiles, and, among mammalia, in many Cetacea (whales), a few marine carnivora, and all the Edentates. The mandibular teeth of the sperm-whale and the tusks and molars of the walrus, in the collection, are devoid of enamel, being formed of dentin surrounded by cement. There is reason, however, to believe that absence of enamel is an acquired condition, since an

enamel-organ is *developed*, as proven by Tomes, in at least one family of Edentates, in all of which order, as above noted, the teeth are devoid of this tissue.

Cement may be entirely absent, as in the teeth of snakes; it may completely cover the root, as in man, or the crown as well, as in most Ungulates (hoofed animals). The *typical* position of cement is *outside of the enamel*, where it probably exists in the young human tooth as a portion of the much-debated Nasmyth's membrane.

The Typical Tooth.

Again, the majority ruling, simple conical teeth, either fixed on end by ankylosis or held in position by membrane, must be taken as the vertebrate *type*. By far the larger number of fishes, batrachians, and reptiles develop such simple teeth. Very rarely in fishes and batrachians, and in but a single order of reptiles (Crocodilia), are the teeth implanted in distinct sockets, as in mammals, although an alveolar groove—quite open in the sperm-whale, more contracted in the extinct reptilian Ichthyosaurus, and with rudiments of partitions in some examples of Hesperornis—preceded alveoli, and was of more general distribution.

Evolution of Alveoli.

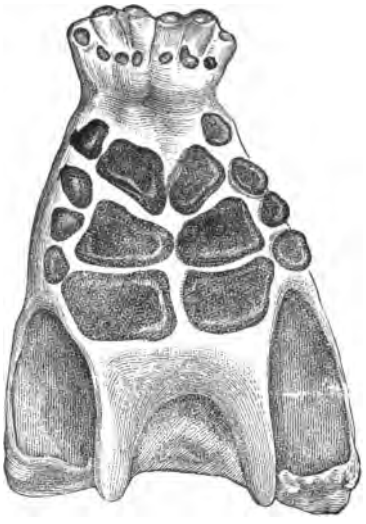
Seldom has evolution been more beautifully demonstrated than by Professor Marsh in those ancient toothed birds of the cretaceous, the Odontornithes,[1] which his investigations have made known to science. Here are the almost imperceptible stages of transition from alveolar grooves to sockets. The Hesperornis before mentioned, occupying the order Odontolcæ (teeth in grooves), exhibits considerable variation in the numerous species figured in Professor Marsh's monograph. In one the jaws have open grooves with parallel sides; in another, faint constrictions, producing a scalloped border, are found; while in yet another, rudimentary partitions appear. Finally, the Ichthyornis, another toothed bird, having acquired distinct sockets, is placed in a separate order, Odontotormæ (teeth in sockets).

Restriction in Number of Teeth.

Contemporary with alveoli, a gradual tendency both to restriction in number and to the development of a definite number of teeth in a given form doubtless arose. Only approximately con-

stant in number in the various species of crocodiles (in whom the right and left series are seldom identical in number), a more arbitrary limitation marks the mammalian dentition, particularly in the higher orders. It is interesting to note, in certain species, as Dasyurus among marsupials, a marked tendency to develop supernumerary teeth. Mammals as a class, however, are singularly restricted as to the number of teeth present, for, whereas the *typical mammalian dentition* (which, by the way, few of them pos-

FIG. 9



Skull of *Placodus*, an extinct Saurian.

sess) is three incisors, one canine, four premolars, and three molars on each side of each jaw (written i $\frac{3}{3}$ c $\frac{1}{1}$ p $\frac{4}{4}$ m $\frac{3}{3}$), or 44, the number of teeth present in a vertebrate may range from many scores, in certain lizards, to hundreds, and even thousands, in some fishes.

Location of Teeth.

When teeth appear upon the roof of the mouth in man we deem them abnormal, yet there are time-honored precedents for the position assumed, since in some reptiles, in many batrachians, and in most fishes palatal teeth are the rule. Batrachian teeth generally occur on the intermaxillaries, superior and inferior

maxillaries, vomer, and palatines, and occasionally upon the parasphenoids and pterygoids as well. Those of fishes may cover all the osseous and cartilaginous parts of the buccal cavity, the branchial arches, and, in rare cases, even the *nasals* and the occipital, or they may develop external to the mouth, as in the saw-fish (*Pristis*). The only edentulous bones in the oral region of many fishes are the *true maxillaries*.

Anchorage.

Implantation, truly so-called, is but one of many methods of attachment. It necessitates alveoli or grooves, and is distinguished from other forms of anchorage by the term *thecodont*. Teeth may be attached indirectly to the jaws by the interposition of a modified mucous membrane, as, throughout life, in sharks and rays and in the young of many true fishes. In the adult of many fishes, particularly the ganoids and teleosts, an osseous pedicle, developed from the underlying bone, becomes firmly ankylosed to the base of the tooth, to be resorbed when the tooth is lost. This, the *alveolar eminence* of Owen, is peculiar to fishes. Direct ankylosis of the bases of the teeth to the jaws is the rule among certain lizards, and is designated as *acrodont*, as opposed to *pleurodont*, by which term are described teeth ankylosed to the *side* of a socket or groove, laterally fixed in the jaw, as is the case in a group of lizards, of which the Iguana is a type; or, as in the Pike or Angler-fish, certain of the teeth may be *hinged*, the hinge opening *inward*, thus permitting easy entrance to living prey, after which, springing back to the erect position, they offer a formidable obstacle to egress.

Of living vertebrates, only mammals possess teeth implanted by two or more roots. For many years the oldest known evidence of the class, a couple of minute teeth, discovered in 1847 by Professor Pleininger, of Stuttgart, in sand from the Rhætic formations of the triassic period, were by this feature identified as mammalian, although hidden among the teeth and skeletal fragments of countless fishes and saurians. A small carnivorous mammal was indicated as the only possible possessor of these teeth, and accordingly *Microlestes antiquus* arose, phœnix-like, not from his ashes, but from his molars.

Number of Successional Series.

Another important point wherein mammals differ from the rest of the vertebrates is in the number of sets of teeth erupted during the life of the individual. Odontologists recognize three distinct types of dentition, looked at from this standpoint, as follows:

Monophyodont, developing but a single set of teeth.

Diphyodont, developing two sets, an earlier, or deciduous, and a later, or permanent set.

Polyphyodont, developing teeth as required, without restriction as to number of successors.

Furthermore, the method by which the new tooth takes the place of its predecessor is variable. Thus, it may be by a vertical movement, as in man and most mammals, certain reptiles, and even in some fishes, as the trigger-fish (*Balistes*).

Or the young tooth forming at the side of its functional progener may laterally tunnel into the base of the latter, and, developing, lift it out of the jaw, as in Varanus, a lizard.

The permanent tooth may develop at the side of its deciduous predecessor in mammalia, as is the case with the canines of the Felidæ. (The kitten's skull in the collection illustrates this point.) Thus only is it possible to develop the new canine without disarming the animal during the period of eruption, as would result were the deciduous canine rapidly resorbed. Horizontal procession may be the method of renewal, the worn anterior tooth moving forward to make room for the new tooth, as is the case in the elephant. A similar mode of succession characterizes the parrot-fish (*Scarus*). Lastly, progression by rotation forward over the jaws of a tooth-bearing membrane, as already noted in the sharks.

Differentiation of Teeth.

The teeth of the majority of both monophyodont and polyphyodont vertebrates are simple in form, while those of diphyodont animals, embracing most of the orders of the mammalia, are specialized; that is, they are differentiated as incisors, canines, premolars, and molars. This differentiation, due to long-continued stress and stimulation, constitutes the mammal's sole claim to dental superiority. We distinguish this diversity in form and division of labor of the teeth by the term *heterodont*, as opposed to *homodont*, where the teeth are all much alike in form and size.

A *heterodont dentition*, using the term in Owen's original restricted sense, is found only in mammalia, although numerous examples of a partial differentiation may be cited among fishes and reptiles. To some of the former class, in fact, *heterodont* is a necessary appellation.

As a rule, then, diphyodont mammals are heterodont, and monophyodont and polyphyodont animals homodont, although to this statement many exceptions may be taken. Thus, the wolf-fish (*Lupus*) exhibits great diversity of form in its denture; the entire armadillo sub-order (*Loricata*) have simple teeth, but these are preceded by a deciduous set.

A hint of the ancient affinities linking the modern diphyodont mammalia with their polyphyodont reptilian and piscine contemporaries is contained in the circumstance, proven by recent investigations, that in every case where the dentition is restricted to two series, germs of a third (and possibly of a fourth) series are found. This may explain the appearance, in rare instances, of a third set of teeth or of a crop of simple denticles in man.

Evolution of the Heterodont Dentition.

In the differentiated teeth of the heterodont mammalia the cheek-teeth or molar series have enlarged their crowns, consisting, typically, of several cusps, either paired or alternate, and occasionally much disguised by blending, connecting ridges, or modification in form. It is probable that the many diverse types of molar are all derived from a simple triconodont type, such as persists to-day in certain marine carnivora, the sea-leopard (*Ogmorhinus leptonys*), the gray seal (*Halichoerus grypus*), and others. From the triconodont type, the transition to the tritubercular superior molar, so common in the Puerco epoch, is easy, and the various steps by which the quadritubercular, quinquitubercular, and sextitubercular molar was probably derived from this triangular form have been most ingeniously described by Professor Cope in his brilliant essay, "On the Homologies and Origin of the Molar Teeth of the Mammalia Educabilia." The triconodont type itself doubtless arose, as suggested by Cope, from the simple conical tooth by the addition of tubercles, stages of which evolution may be seen in the teeth of sharks, the Squalodon, and Zeuglodon, among extinct cetacea. In predaceous

mammals the teeth located at the angles of the mouth, used to transfix and hold struggling prey, also became thicker and longer than the incisors, but with simple, conical crowns. As the lower canine, closing outside of the upper, would be drawn forward (and with it, of course, the lower jaw) by an increase in diameter of the superior canine, or the lower, or both, we have here, in the evolution of the canines, an example of nature's method of "jumping the bite" some ages ago. In rodents, whose canines

FIG. 10.

Tooth of *Zeuglodon.*

FIG. 11.

Skull of *Castoroides Ohioensis.*

are lacking, the immensely developed central incisors indicate that these teeth perform the heaviest and most powerful labor of which their jaws are capable.

The fossil beaver of the collection is a notable example of specialized incisors. (See Fig. 11.) This enlargement of a tooth in transverse diameter is believed to be the result of the stimuli of impacts upon the developing tooth-germ, handed down, with added accretions, from generation to generation. As the pressure exerted by the masseter and temporal muscles was greatest in the immediate vicinity of the application of power,—*i.e.*, of their insertion,—we should find the teeth in this position the largest. Not only is this true of the molars generally, but the relative size

of these teeth, when unequal, depends upon location, those directly beneath the anterior border of the masseter being the largest. In the carnassial teeth of carnivora an anterior progression of the insertion of the masseter has been accompanied by a corresponding movement in the development of the teeth, until we have here a *premolar* occupying the position of greatest pressure and attaining the largest size of all the cheek-teeth. The *mechanical* origin of the molar series is further proved by the researches of Dr. Galippe upon the *specific gravity* of the teeth,* in which he found that the molars have a greater density than the incisors. Chemistry has also cast a ray of light on this interesting point in evolution. C. S. Tomes states† that his investigations indicate very plainly that the molars and bicuspids are more highly calcified than the incisors and canines. Man is by no means the only species in whom the posterior molar tends to degenerate. In the cats, to use an extreme example, both third and second molars have completely disappeared, while the first superior molar is a mere functionless denticle.

Causes of Diminution in Number of Teeth.

Beside this degeneration through disuse, we find, with increased specialization, a gradual diminution in the number of the teeth, due to two distinct causes:

First. The progressive enlargement of the more actively functional molars results in the displacement of the less useful teeth by their more energetic neighbors.

Second. A shortening of the entire jaw to increase the power of the bite. This decreasing of the adverse leverage of the jaws likewise results in the crowding out of such teeth as can be more readily spared. Thus, of existing Eutheria (the Monodelphia or placental mammals), but four genera have the full complement of forty-four teeth. Of the dentally specialized Fissipedia (terrestrial carnivora), the Canidæ have, as a rule, forty-two teeth, as follows: $i\ \frac{3}{3}\ c\ \frac{1}{1}\ p\ \frac{4}{4}\ m\ \frac{2}{3} = 42$. Here the superior third molars ($\frac{m^3}{-}$) are suppressed.

*"Recherches sur le Proprieties Physiques des Dents." Society de Biologie, 1884.

†*British Journal of Dental Science.*

In certain Asiatic species the inferior third molars ($\frac{-}{m^3}$) are also lacking, while the crab-eating dog of South America (*Canis cancrivorus*), whose diet is not strictly carnivorous, occasionally presents the typical forty-four teeth.

The omnivorous bears (*Ursidæ*) develop forty-two permanent teeth, some of which, however, are lost before the animals attain maturity.

Of Procyonidæ, the raccoon has forty and the panda thirty-eight teeth, the latter having lost the superior fourth premolar ($\frac{p^4}{-}$), in addition to both inferior and superior third molars ($\frac{m^3}{m^3}$); the dentition of Cercoleptes (the kinkajou) is reduced to thirty-six, he dropping the inferior fourth premolar ($\frac{-}{p^4}$) as well. Of Mustelidæ, the common skunk (*Mephitis mephitica*) presents but thirty-four teeth, the superior second molar (m^2) being suppressed, while in the skunk of Tropic America (*Conepatus mapacito*) the cancellation of p^3 reduces the number to thirty-two.

Finally, among the Felidæ, or cats, the highest carnivorous type, the dental formula is reduced to thirty, as follows: $i\ \frac{3}{3}\ c\ \frac{1}{1}\ p\ \frac{3}{2}\ m\ \frac{1}{1} = 30$.

It is apparent that here, in the mammalian dentition, a struggle for existence has centered,—a vendetta extending through countless generations, and of which the survivors, the battle-scarred veterans of the alveolar arch, are pre-eminently "the fittest."

Varied Functions of Teeth.

Alimentation is by no means the only function to which these organs are subservient. Among primates, where the limbs attain their highest development as prehensile organs, the teeth seem to have lost, in great measure, this primitive function, almost their only one in reptiles and in many fishes. Tactile sensibility is, however, still retained, probably in greater perfection here than in the fingers, calloused by climbing, of all but the highest type, the civilized (softened) races of man. The savage of to-day still uses his teeth as a court of final appeal in examining unknown substances. The universal habit of babies of all races of putting everything that comes within their grasp into their mouths is not, as commonly believed, the manifestation of an insatiable appetite, but an instinctive method of physical diagnosis, to be

suppressed only by continual chiding and punishment. Here, also, in the herbivorous or omnivorous primate, the *sexual tooth*, or canine, is commonly much developed in the adult males, where it is utilized, during the breeding season, in those combats which, as Darwin pointed out, result in a "sexual selection,"—in a progeny sired by champions, and in whom the features that contributed to victory are preserved and further developed by their heirs. The polygamous Ungulates likewise develop armed males, existing members of which order may bear horns or antlers, or enlarged canines, never both. The horse, among Perissodactyla (odd-toed Ungulates), and the wapiti and musk-deer, or Artiodactyla (even-toed Ungulates), are examples. The extinct Dinoceros

FIG. 12.

Elephas primigenus (Mammoth).

FIG. 13.

Skull of *Dinotherium*.

and its gigantic allies, nevertheless, were furnished with not one, but *three* pairs of horns, in addition to the long, lanceolate canines of the male. A sexual development of the *incisors*, notable for its lack of symmetry, characterizes the male narwhal (*Monodon monoceros*), in whom the *left incisor* projects as a huge, sinistrally convoluted ivory tusk, sometimes attaining a length of seven or eight feet in old bulls. (A fine example of this tooth is to be seen in the collection.) The right incisor, although present, remains rudimentary within the socket, as do both of the incisors of the female. Sometimes, however, the *right* tusk of the male also erupts, equaling the left in length. (A narwhal presenting this rare condition was exhibited at the Berlin Fisheries Exposition of 1878.) This tooth, the only example of unpaired development or asymmetry in the whole range of existing mammalia,

finds its parallel in the lower incisors of the extinct Mastodons, the left of which, in the American species at least, sometimes projected from the male jaw as a short, straight tusk. The paired tusks of the elephant and mastodon, huge superior median incisors, are the largest teeth known. Those of *Elephas primigenus*, an extinct Northern species, were thirteen feet eight inches long and forty inches in circumference at the base, producing, by their leverage, a downward strain of nearly two thousand pounds on the inferior walls of their alveoli. The immense frontal depression seen in the skulls of all elephants, living or extinct, marks the insertion of the huge muscles needed to wield their incisors. While larger in the males, both sexes of Proboscidians are armed with tusks as weapons of defense.

That strange transitional type, the Dinotherium (a cast of whose huge skull confronts one on entering the Museum Hall), developed its inferior incisors, in both sexes, as *downward-pointing* tusks, which probably served as picks in its aquatic exploration of ancient river-bottoms. The functionally similar tusks of the walrus, also exhibited, are superior canines. The upward- and backward-pointing tusks of the Babiroussa, useless as weapons, serve to protect the eyes of this hog when running through thick undergrowth. The inferior median incisors of the kangaroo are said to be utilized as scissors, the sharpened mesial border of one working against that of its neighbor by independent movements of the two rami, which retain a mobile, ligamentary union at their symphysis. Thus, it is asserted, did this pest of the Australian cattlemen *shear* the herbage so closely that sheep starved by thousands on kangaroo ranges. The incisors of most lemurs protrude in a manner that unfits them for prehension. We are therefore prepared to learn that they are employed as a comb during the animal's toilet. The nippers of the Ungulate, the scrapers of the Carnivore, the forceps of Insectivores, are incisors. The poison-fangs of the rattlesnake, analogous to canines both in function and position, offer the earliest pattern of a hypodermic needle,—a pattern that actually suggested placing the orifice of the duct of the modern needle on the side instead of at the end, as in the earlier canula.

The molar series, when differentiated as such, are strictly masticatory or cutting in function.

Equality in Height of Teeth a Primitive Characteristic.

We have seen that increased specialization of function, so marked in the mammalian dentition, is concomitant with differentiation in form and size. Thus, the teeth of the more highly specialized modern orders present diversities in height, profound in Carnivora and Rodents, less marked in Cheiroptera, Insectivora, and Ungulates, but seldom entirely absent.

The existing Cetacea (Mesoplodon excepted), the Edentata, in common with the extinct Achænodon and Hyopsodus,—those primitive Ungulates of the early eocene,—have subequal teeth. Of primates, absolute uniformity in height seems to be not only confined to man, but to civilized man at that, the male aborigine of many races not infrequently exhibiting in a slight degree the so-called *simian* feature of enlarged canines. It has been suggested to me by Dr. Hutchinson that the mastoid process, the greater size of which in the male may be classed as a secondary sexual characteristic, is developed in direct relation with the canine, for the *sterno-cleido-mastoideus*, which takes its origin here, is especially concerned in *tipping the head to one side* and in *rotating it*, motions that are used respectively in attack and in shaking the captured prey. A dog holding a rope by his canines well illustrates these actions; whereas, if the rope be held by the incisors, the head is kept level, while a strong backward pull is his usual procedure.

Contemporary with this equality in size of the ancient generalized (and modern degenerate) denture existed an uninterrupted series—an absence of *diastemata*—of the spaces separating certain of the teeth in all existing mammalia save man.

Some species of Titanotheria, the Achænodon, the Anoplotherium, the Homalodontotherium,—in fact, many of the early tertiary mammalia,—exhibit this primitive feature, so conducive to caries and oral deformities. The tooth-brush, then, is a necessity, not of a specialized, but of a very old-fashioned, type of denture.

Zoological Chauvinism.

Yet the same smug self-complacency that prompted "Little Jack Horner," upon finding the historic plum, to exclaim, "Oh, what a good boy am I!" permeates the pages of too many narrow text-books on the structure of man.

It is a survival of an age when to question the physical superiority of man over "the brutes," as all other mammals were contemptuously termed, was rank heresy. The very titles of the once-famous "Bridgewater Treatises" (now buried in oblivion, although antedating the "Origin of Species" by but twenty-six years) serve to illustrate the curious distortion of facts,—the childish theories of their scientific authors. Thus, we have Kidd's "Adaptation of External Nature to the Physical Conditions of Man" (1833), Chalmers's "Adaptation of External Nature to the Moral and Intellectual Conditions of Man." It was this school of philosophers who discovered that the horse's molars were separated from his incisors by a gap (diastema) solely to enable man to govern him by means of a bit, though why we do not subdue the lion or the wild boar by the same means was not explained. Nor had Professor Marsh then given to the world the pedigree of this noble animal, whose diastema is now known to have existed ere human foot trod *terra firma*. How fortunate for Bell's argument that he selected the *hand* rather than the *foot* of man for his famous monograph on our structural superiority, for although the human hand is pre-eminent as a prehensile organ, in the latter extremity, as in his teeth, the horse is immeasurably our superior!

Before pointing out the zoological position of the human molar teeth as compared with the various types of molars found among the mammalia, an examination of these principal forms, as defined by Cope,* may serve to bring the subject more clearly before us.

Four well-defined types of molars are found in mammalian dentures, as follows:

I. *Haplodont type.*—The crown undivided or simple. Existing toothed whales, some carnivora, edentates, and certain rodents, have teeth of this description.

II. *Ptychodont type.*—The crown folded on the sides, the folds frequently crossing the crown. Most rodents bear molars of this type.

III. *Bunodont type.*—Crown supporting tubercles. The molars

*"On the Homologies and Origin of the Types of Molar Teeth of the Mammalia Educabilia," *Journal of the Academy of Natural Sciences*, Philadelphia, 1874.

of a few existing and many extinct ungulates, carnivores in general, and most primates, including man, are of this type.

FIG. 14.

Walrus.

FIG. 15.

Dolphin.

FIG. 16.

Sloth.
(Actual size.)

MOLARS OF HAPLODONT TYPE.

FIG. 17.

Beaver.

FIG. 18.

Rabbit. (Actual size)

MOLARS OF PTYCHODONT TYPE.

FIG. 19.

Peccary. (Actual size.)

FIG. 20.

Mastodon. (×¼.)

MOLARS OF BUNODONT TYPE.

IV. *Lophodont type.*—The summit of the crown thrown into folds of transverse or longitudinal direction. The Lophodonts comprise the higher ungulates and some rodents.

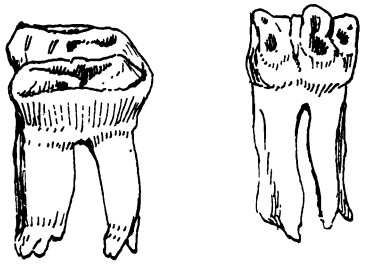
The derivation of the bunodont from the haplodont type, by a development of accessory tubercles on the crown of the primitive

tooth, and the gradual evolution of the lophodont type from the bunodont, are inferences toward which a study of the paleontological evidence inevitably leads. The highest stages of development to which the molar teeth have attained are found among the terrestrial carnivora on the one hand and the higher ungulates on the other, both of which orders (together with the remainder of the Educabilia) are probably derived, as believed by Cope, from a bunodont ancestor, having plantigrade pentadactyle feet. In fact, the primitive bunodont type of molar characterized the mammals of the early Eocene period. But we ourselves are plantigrade, pentadactyle bunodonts.

FIG. 21.

Elk.

FIG. 22.



Manatee.

MOLARS OF LOPHODONT TYPE.

So that, here again, man's vaunted superiority of structure disappears on close inspection. To quote Cope, "In his (man's) teeth his character is thoroughly primitive. He possesses, in fact, the original quadrituberculate molar with but little modification. His structural superiority consists solely in the complexity and size of his brain." Two main factors have contributed to retard the dental specialization of the primates: First, their arboreal habits, which necessitated a diet neither carnivorous nor herbivorous, but frugivorous, and more easily comminuted than either of the former. Second, the presence of highly specialized prehensile fore-limbs, which largely relieved the mouth of its manipulative functions. Add to this, in man's case, the invention of the knife and of cookery, whereby the food is not only reduced to mouthfuls but softened as well, and the causes of our dental inferiority stand

confessed; for the moment a tool intervenes to aid or accelerate the functions of a bodily organ, that moment all onward evolution of that organ ceases. Imagine a beaver armed with an axe in addition to his rodent incisors.

That a retrograde evolution or degeneration of these organs is at work in man is apparent to the student of physical anthropology. To him each upward stride of civilization, of ethnic superiority, is associated with indubitable evidences of structural inferiority; so that the evolutionist's prophetic vision of the "coming man" as a bespectacled, bald-headed, and edentulous individual of infantile proportions but preternatural intelligence, appeals to him as a not impossible result of modern life.

The Teeth as a Factor in Anthropology.

In the study of the human race, not alone the teeth, but the jaws, the palate, and the attachments of the muscles concerned in mastication, are points of vital importance in the differentiation of types. To the dentist, no less than to the professional anthropologist, the methods and results of craniometry are therefore of interest, yet, owing to the scarcity of literature of the subject and the special nature of the instruments employed, the study of the teeth as a factor in anthropology is almost entirely neglected by the dental profession.

The important studies of Dr. Patrick on the teeth of aborigines prove, however, that for certain lines of investigation the dentist is already singularly well equipped.

Of variations due to the development of the muscles of mastication, for example, we have, first, the *comparison of the areas of origin of the temporal muscle.*

The temporal ridges, wanting in the child, are but faintly marked, as a rule, in adult white women; heavier in white men, yet in both circumscribing a rather restricted area. In savage races the areas of origin of the temporal muscles are larger, particularly in males, and the temporal ridges consequently creep higher and higher and lie nearer to the sagittal suture. Thus, in a well-developed representative adult male European, the shortest distance between temporal ridge and sagittal suture is 65 millimeters; while the same measurement on a Papuan man from New Ireland is but 46 millimeters. Obviously the latter had the stronger tem-

porals. Turning to the anthropoids, we find that the female orang, and the young males as well, have temporal ridges more marked than in man, but still separated by a considerable interval from the sagittal suture. As the young male develops, however, these ridges creep upward, until they finally meet and form the immense sagittal crest characteristic of the male anthropoid.

It was by the study of these shifting temporal ridges, in a series of more than thirty skulls, that Mr. Frederic A. Lucas was enabled to prove that two supposedly distinct species of orangs were but young and adult of the one species, *Simia satyrus*.

The areas of origin and insertion of the masseter muscle are indicated by the degree of development of the zygomatic arch and of the ascending ramus of the jaw. Not only are these points of anchorage reduced in size in the female of all human tribes, but it is in the savage that they attain their greatest development, here again approaching the simian condition. The width of the ascending ramus of the lower jaw, taken at the height of the border of the alveoli of the molar teeth, is a convenient index of the development of the masseter muscles. The greater size of the digastric fossæ in the jaws of savages indicates a correspondingly greater development of the digastric muscles.

The Ascendency of Individual Muscles of Mastication

is indicated not only by the asymmetry of the condyles, where the lateral movement has been habitually made in one direction (one condyle serving as a pivot while the other united in the excursive movements of the mandible), but it is also manifested by the outwardly or inwardly everted angle, the former indicating ascendency of the masseter muscles, the latter of the internal pterygoids. The relation of the angle of the jaw to muscular action is well illustrated by the comparison of the jaws of infant, adult, and aged persons. Only during the functional activity of the teeth is the angle approximately a right angle, while in the fetus, during childhood, and in old age the angle of the horizontal with the perpendicular ramus is more open. A similar tendency is believed to result from mouth-breathing. The disappearance of the angle of the jaw here hinted at, and which actually occurs in certain edentulous forms, as the ant-eater and the baleen whales, is due to the absorption of a muscular anchorage when no longer used. So

intimately are ancient ancestral traits incorporated in our psychological make-up that we instinctively recognize a large outwardly everted angle and heavy ramus as correlated with firmness and decision, although many generations must have elapsed since these virtues were actually assisted by the jaws. That the human teeth were once used as weapons is unconsciously revealed, as pointed out by Darwin, in the retraction of the upper lip in anger, which is but a muscular memory of the uncovering of the canines, which, in all canine-bearing mammals, is a preparation for combat.

Another point in which the jaws of aboriginal tribes are, as a rule, superior to those of civilized races is in the proportions of the horizontal ramus. As pointed out by Harrison Allen, the alveolar and inferior borders of the jaw tend to parallelism in savages, while in civilized races the symphysial height is usually greater than the height in the vicinity of the molars. This may be due to gradual degeneration of the platysma myoides muscle. Of the significance of the "antegonium" or "pregonium" of the same author I am uncertain, but incline to the belief that it is a "stigma of degeneration." Finally, an as yet uncompleted study of the relative proportion of jaw to skull has convinced me that the jaws of savages are not only proportionately but actually heavier than our own, and that the "cranio-mandibular index," as I term it, which is the ratio between the weight of jaw and weight of cranium, rises steadily as we descend from semi-civilized to barbarous and savage tribes.

Thus, while the white males examined gave an index (proportion of jaw to skull) of 11.8, the male Australians presented an index of 15.4.*

The facial angle, invented by Camper and subsequently modified by so many craniologists, gives in a general way *the proportion between the brain-cavity and the jaws.* Beginning with the ideal Greek type (found to-day only in statues and hydrocephalics), with an angle of ninety degrees, a gradual lessening of the angle occurs as we descend in the scale of humanity. The fact that the exterior of the skull may be widely separated from the inner table, and particularly at the forehead, to which one arm of this angle is tangent, has gradually tended to invalidate the testimony of this

*For further particulars, see paper entitled "A Cranio-Mandibular Index," read before the Association of American Anatomists at their meeting of December, 1897.

once unquestioned criterion. A more accurate method of arriving at this proportion is by

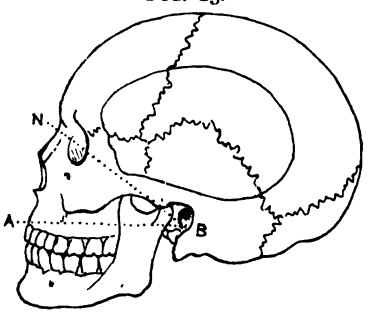
The Degree of Protrusion of the Upper Jaw,

or, as it is technically termed, the degree of *superior prognathism.* This is readily estimated by means of the gnathic index of Professor Wm. H. Flower. In this method the basi-nasal length (see Fig. 23) is compared with the basi-alveolar length, as follows:

$$B\,N : B\,A :: 100 : x, \text{ or } \frac{B\,A \times 100}{B\,N} = \text{gnathic index.}$$

In the classification employed by Professor Flower the arbitrary limits of the three degrees of prognathism recognized are as fol-

FIG. 23.



N.—*Nasion*, the middle of the naso-frontal suture.
A.—*Alveolar Point*, the center of the anterior margin of the upper alveolar arch.
B.—*Basion*, the middle of the anterior margin of the foramen magnum.
BN.—Basi-nasal length, or shortest distance from basion to nasion. (Measured with calipers or craniometer.)
BA.—Baso-alveolar length, or distance from basion to alveolar point.

lows: Orthognathous, under 98; mesognathous, from 98 to 103; prognathous, above 103.

According to Topinard, the races of Europe have the least amount of protrusion, the yellow races and Polynesians much more, and the Negro races still more.

After a careful comparison of the amount of variation for each index taken of the various series of skulls collected by the Challenger expedition, Sir William Turner states that "the gnathic index showed a much greater amount of variation in the several groups than the cephalic or vertical; in only five was the range below 10, while in the remaining seven it rose above that figure, and in the Admiralty Islanders was as high as 18." And again,

"The gnathic index ranks also very high as a racial feature, whilst the other indices to which I have referred (nasal, orbital, facial, etc.) are only of secondary importance." Yet it may be accepted, as a rule, that extreme prognathism is found only among very low races of men.

That prognathism is an acquired character, due to the late period at which the child is weaned among primitive people, as suggested many years ago by Lawrence, and later by Owen, is a more

FIG. 24.

Skull of Negro, Fan Tribe, West Africa.

ingenious than satisfactory explanation of this phenomenon. It has, indeed, been denied that prognathism could be detected in the young children of those races whose adults are so characterized. Yet the skull of the Negro baby at birth, included in the collection, has an index of 98.1, or considerably higher than that of the white child at birth. Evidently, here, prognathism is an inherited feature.

The profile of the skull of a Negro of the Fan tribe, of West Africa, well illustrates this condition, so ape-like in appearance. In direct relation with the protrusion of the jaws is the position of the third molar. In whites the distal border of the inferior third

molar (m^3) extends beyond the anterior border of the ascending ramus, so that in a lateral view of the jaw it is partially or totally hidden. In savages, on the contrary, the distal border of the third molar is in front of the border of the ascending ramus, as in anthropoids generally. Confluence of the roots of the superior third molar, likewise an indication of degeneracy, is probably a sequence of its disadvantageous location and occasional total lack of occlusion with its inferior antagonist, in the civilized races. In savages, as in anthropoids, its three roots are free and diverging. Both m^3s of the Fan skull figured have as well-formed roots as the ordinary Caucasian m^1.

Four Forms of the Superior Alveolar Arch

were recognized by Professor Broca as constituting ethnic characteristics.

I. *The Hyperbolic.*—In which the branches of the arch diverge posteriorly.

II. *Parabolic.*—"Where they still diverge, but in such a manner that if prolonged they would eventually return upon themselves and meet."

III. *U-shaped.*—When the sides of the arch are exactly parallel.

IV. *Elliptical.*—When they converge, whatever the degree of such convergence may be. Of them Topinard says, "The first two and noblest forms are common in the white races; the third and fourth are rare, and are especially seen in black races; the form of the letter U is that of anthropoid apes; the elliptical is seen in the sagon and the macaque."

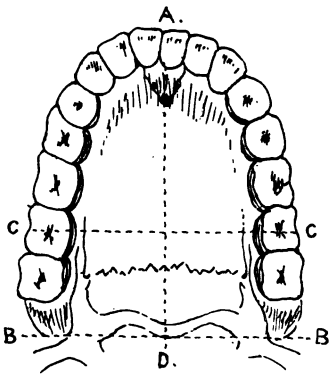
The form of the palate is recorded by the *palato-maxillary index* of Professor Flower, which differs considerably from the palatal index of Broca. In the former the width of the alveolar arch is compared with its length. The accompanying diagram (Fig. 25) is self-explanatory.

In the proportion A D : C C : : 100 : x, x is the desired index. Three varieties are recognized, with the following limits: *Dolichuranic,* index below 110; *mesuranic,* between 110 and 115; *brachyuranic,* above 115. The form of the palate is correlated with that of the skull; thus a brachycephalic skull will present a brachyuranic palate, a long skull a long palate, etc.

Of the crania of races collected by the Challenger expedition,

those of the Australians possessed the largest palato-alveolar arches. In his general summary of the "Report on Human Crania,"* Sir Wm. Turner says, "A long palato-alveolar arch is to be regarded as a sign of degeneration of the human cranium, and this is the more marked when it is associated with relative narrow-

FIG. 25.



A.—Alveolar point, or middle of superior alveolar arch.
B B.—A line drawn across the posterior borders of the maxillary bones.
A D.—Length of palate.
C C.—Width of palate, taken between outer borders of alveolar arch immediately above the middle of the second molars.

ness and the consequent production of a low palato-maxillary index." He also calls attention to the fact that the length of this region in adult anthropoid apes is "invariably considerably greater than the breadth, so that the palato-maxillary index is very low."

The Wear of the Teeth.

The naturalists' dictum that "the age of an animal is determined by the duration of its teeth" has ceased to apply to man, although surviving in the old saying that "every tooth lost from your head is another nail in your coffin," or words to that effect. It is unusual among civilized men to find a denture in which the cusps of the molars are worn entirely smooth, while certain extreme conditions of wear seem to be restricted to aborigines.

Broca, who contributed so much toward lifting physical anthropology to the plane of an exact science, has left us a method, at once rapid and accurate, whereby the degree of wear of the teeth

*The Voyage of H. M. S. Challenger. Zoology.

in a given denture may be recorded. He recognized four degrees of wear:

In the *first* the enamel alone is worn, without any obliteration of the cusps (Fig. 26).

FIG. 26.

European.
FIRST DEGREE OF WEAR.

FIG. 27.

Mariori, Chatham Id., N. Z.
SECOND DEGREE OF WEAR.

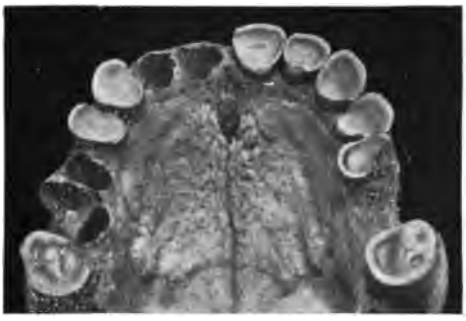
In the *second* degree the tubercles of the crown have disappeared, and the dentin is exposed (Fig. 27).

In the *third* degree of wear the height of the tooth is still further reduced (Fig. 28), while in the *fourth* the wear has extended to the neck, the crown having entirely disappeared, while either the pulp-

cavities are invaded or barriers of secondary dentin have formed (Fig. 29).

That the degree of wear is an index of age is true only of civilized races, where the teeth are used exclusively for mastication.

FIG. 28.



American Indian.
THIRD DEGREE OF WEAR.

FIG. 29.

Aborigine, San Maguil Id., Coast of California.
FOURTH DEGREE OF WEAR.

Among aboriginal and semi-civilized tribes the wear may indicate diet or particular habits. Thus the skulls of the mound-builders of Florida exhibit teeth the extreme wear of which is attributed to the sand with which their food must have been unavoidably adulterated. The combined action of the silica of the corn and of

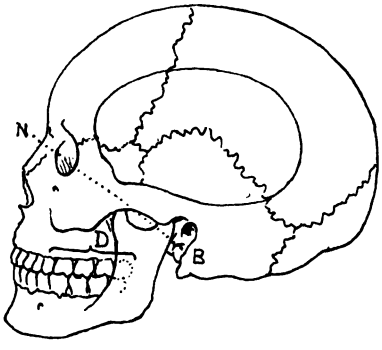
the pulverized particles of the *metate* or primitive stone mill within which it was ground account satisfactorily for the condition of wear observed in young adult Pueblos and other sedentary Indians, while the chewing of the betel nut among the Malays and Polynesians contributes to the same end.

Nowhere, perhaps, are the teeth subjected to greater wear than among the Hyperborean races, the Esquimaux, Laps, Fins, etc. Here the manipulation of skins for robes and clothing is performed principally by the jaws, and it is reported that the skins of the eider duck are thus prepared by chewing by the children in the schools of Iceland.

The Dental Index.

It remained for Professor Wm. H. Flower, the celebrated English anatomist, to discover a natural racial grouping of mankind by their teeth. He takes the length in a straight line of the five teeth of the upper molar series *in situ* ($\underline{p^{1 \text{ and } 2}}$ and $\underline{m^{1,2, \text{ and } 3}}$), measuring from the mesial border of the first premolar to the distal border of the third molar, as the ***dental length*** (D).

FIG. 30.



This is compared with the cranio-facial axis or basi-nasal length (B N); the latter estimated as 100. This axis is measured from the *nasion* (naso-frontal suture) to the basion (the middle of the anterior border of the foramen magnum). Then in the proportion D : B N : : x : 100, x is the dental index, or $\frac{D \times 100}{B\ N}$ = dental index.

The basi-nasal length can obviously be measured directly only upon the denuded skull, but it may be estimated on the living subject by projecting the nasion and the auricular point (center of the

external auditory meatus) upon a plane surface and there measuring the distance between these points. The dental indices are grouped under three series, as follows: *Microdont*, below 42; *mesodont*, between 42 and 44; *megadont*, above 44.

We have seen that the dental index thus arrived at is the proportion between the length of the superior molar series and the basi-nasal length. To bring a given race within the megadont series, for example, one of two conditions must be present: either the dental length must be great or the basi-nasal length small. In the latter event the term *megadont* would be merely relative; in the former positive. Theoretically it would seem that the cranio-facial axis, embracing as it must the cerebral fossa, would be at its maximum in civilized races. An inspection of the following chart* proves that this is not the case.

PROFESSOR W. H. FLOWER'S CLASSIFICATION OF THE HUMAN RACE.

	Sex.	Number of Observations.	Average Basio-Nasal Length.	Average Dental Length.	Average Index.	Average Index of Both Sexes.
MICRODONT RACES.						
British	M.	20.	100.0	41.0	41.0	41.3
	F.	13.	95.	39.5	41.6	
Mixed Europeans (not British)	M.	52.	101.3	41.0	40.5	41.1
	F.	14.	95.1	39.6	41.6	
Ancient Egyptians	M.	7.	101.4	41.4	40.8	41.0
	F.	8.	95.9	39.5	41.2	
Polynesians (mostly Sandwich Islanders)	M.	22.	105.3	42.2	40.1	
Low Caste Natives of Central and Southern India (mostly M)	.....	42.	99.5	41.2	41.4	
MESODONT RACES.						
Chinese	M.	12.	98.8	42.1	42.6	
American Indians of all parts	M.	31.	99.2	42.5	42.8	
Malays of Java, Sumatra, etc	M.	70.	99.7	43.2	43.3	
African Negroes of all parts	M.	44.	103.0	44.5	43.2	43.9
	F.	26.	97.9	43.6	44.6	
MEGADONT RACES.						
Melanesians (of various islands)	M.	21.	102.3	45.2	44.2	
Andamanese	M.	9.	94.4	41.9	44.4	45.5
	F.	8.	88.8	41.2	46.5	
Australians	M.	22.	102.5	45.9	44.8	45.5
	F.	14.	95.5	44.0	46.1	
Tasmanians	M.	9.	100.0	47.5	47.5	48.1
	F.	4.	95.5	46.5	48.7	

*Reproduced from a chart published by the U. S. National Museum.

Among the microdont races the Polynesians show a much longer basi-nasal diameter than either Europeans or ancient Egyptians. This diameter is indeed surprisingly similar among the British, the mixed Europeans, and the Egyptians, ranging from 100 to 101.4 millimeters for the males and from 95 to 95.9 millimeters for the females. It is a curious fact that the British microdonts of either sex have almost precisely the same basi-nasal length as the megadont Tasmanians,—namely, 100 millimeters for the men and 95 to 95.5 millimeters for the women. But the dental length is observed to be shorter in the microdont series than in either the mesodont or megadont series, with two notable exceptions. The Polynesians give an absolutely longer dental length than that of the mesodont Chinese, for the reason that the skulls are larger in all their dimensions in the former race. On the other hand, the Andaman Islanders, although megadonts, have a dental length but little in advance of the European, and considerably under the Polynesians. This is owing to the circumstance that their skulls are exceedingly small,—microcephalic in fact,—a feature in keeping with their stunted stature. But, with these exceptions, there is an absolute as well as a proportional increase in the size of the molars, corresponding with the rise in the dental index.

That the lowest known races of mankind should have the largest teeth, the heaviest jaws, the greatest prognathism, and forms of palate and of dental arcade similar to those of the anthropoid apes, are facts whose significance, from an evolutionary standpoint, cannot be ignored.

And as the heraldic devices of a coat of arms convey to the practiced eye information concerning forgotten ancestors and their valiant deeds, so too, I believe, is man's genealogy blazoned on his molars, where he who will may read.

SECTION I.—Continued.

Opening the Bite with Cap-Fillings without Destroying the Vitality of the Pulps of the Teeth.

PAPER BY M. F. FINLEY, OF THE SECTION.

I WISH to present to your attention a case which has been of considerable interest to me, in that I do not know of a similarly treated case, nor have I found, in my limited consultations with brother practitioners, any one who knows of a similar one; therefore, I presume to ask your consideration of my statement of conditions and plan of procedure:

The patient, male, aged sixty-two years; every tooth present in upper jaw, and all in regular position with exception of left cuspid, which closed inside its opponent of the lower jaw; the four incisors were very much worn, so that the palatal surfaces presented a straight line, or inclined plane, from labio-incisive edge to palato-gingival line; these same incisors, when jaws were closed, came in contact with and pressed upon the lower gums. The bicuspids and molars of the left side showed some effect of mechanical abrasion, the outer cusps lapping pretty well over the outer, or buccal, side of the lower teeth opposite, the bicuspids and molars of the right side showing scarcely any wear at all. On the lower jaw the first and second molars, right side, were lost, accounting for the last-mentioned condition in the upper jaw, at the same time throwing the work of mastication almost entirely upon the left side of the mouth, and, in consequence, causing the wear spoken of on the teeth of that side on the upper jaw, the lower teeth suffering more loss of tissue than the upper ones, and they also being, as it were, driven down into their sockets from the undue pressure, as appears in the model.

The lower incisors were worn to an inclined plane, presenting a surface opposite that of the upper incisors, the plane running from the palato-incisive edge to the labio-gingival line and the incisive edges impinging on the upper gums when teeth were closed.

My belief is tnat quite a good deal of the responsibility for the excessive wear of the teeth and the depressed condition of the lower teeth, left side, is due to the malposition of the left upper cuspid, one of the main abutments of the arch being so misplaced as to offer no resistance to the settling together of the two jaws; whereas, if the cuspid had been in its normal position, or had been forced there by regulating at the proper age, it would have been quite impossible for such a condition to have attained.

FIG. 1.

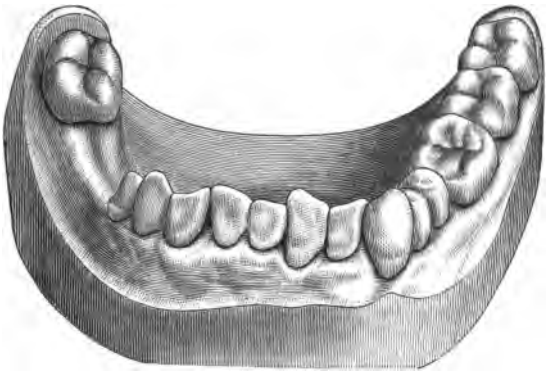
CASE IN OCCLUSION BEFORE TREATMENT.

The contact of the front teeth with the gums opposite in closing the mouth, and the close proximity of the outer cusps of the upper molars of left side with the gums of the lower jaw, forcing the food in the process of mastication in painful contact with said gums, caused the patient so much discomfort that he sought relief, or at least advice, as to what might be done to the best advantage to obtain same.

After taking impressions and getting models, my first thought, or inspiration, if I may so call it, was to open the bite with cast or struck-up slabs of metal, or cap-fillings, as I have decided to designate them. How to attach the cap-fillings was the question to be solved. On consulting several of my brother practitioners,

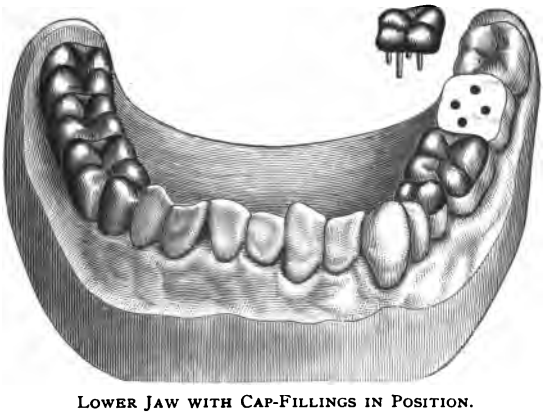
all at first seemed to oppose my plan as not being at all feasible. First thoughts or impressions are the most lasting, and there was no exception to the rule in this instance, as I persisted in my belief that a way could be found to attach these cap-fillings which would be satisfactory alike to patient and operator.

FIG. 2.



LOWER JAW BEFORE TREATMENT.

FIG. 3.



LOWER JAW WITH CAP-FILLINGS IN POSITION.

My reason for not crowning the teeth, as was advised by some, was, that too much tooth-structure would have been sacrificed upon the approximal surfaces in preparing for such a procedure to satisfy my conscience; the teeth were not decayed or broken, but were worn down; also, all the teeth had living pulps, and I

was afraid to disturb the relation of the gums to the necks of the teeth so much as would have been required to have placed crowns over three adjoining teeth with no teeth missing to afford easy access to any of the surfaces to be cut away.

Now for my plan of procedure:

The second bicuspid and first and second molars on left side, lower jaw, were restored or built up with these cap-fillings, and the second bicuspid and third molar, right side, lower, were crowned to carry a bridge to replace the lost first and second molars, the occlusion raised to correspond with the opened bite.

In preparation for these cap-fillings, the occlusal surfaces of the teeth to be capped were ground so as to make them nearly a plane, though not absolutely so, then taking an impression in moldine, and making die and counter with Melotte's metal, struck up pieces of nearly pure gold, about thirty-two gauge, to fit these ground surfaces, and, drilling four holes in the molars and three in the bicuspid, punched holes in the little pieces of gold to correspond in position, and soldered platinum pins in them, and then united to them cusps struck up on a die-plate and filled, thus making a cap of considerable thickness.

I ought also to say that the first piece of gold stamped to fit the tooth was thickened by a second piece stamped over the first and united to the first before the pins were soldered in; twenty-carat solder was used in fastening the pins and filling the cusps, and the two pieces united with eighteen-carat solder.

As to the location of the pin-holes in the molars: I drilled them at a safe distance from the margins of the occlusal surface of the tooth in the centers of the four sides, by this means avoiding the cusps, and thereby, also, the cornua of the pulp, for, as before stated, all the teeth had living pulps.

As a result of my labors, the second bicuspid and first and second molars of the left side, lower jaw, were raised with cap-fillings, the approximal surfaces of the teeth not being disturbed in their relations one with the other, and the second bicuspid and third molar of the right side made to carry an all-gold bridge, thus raising the bite and restoring the lost masticating surface, preventing contact of the front teeth with the gums, and opening the bite sufficiently to prevent pain during mastication. The cap-fillings were fastened with cement, as was also the bridge, and all

set at the same time, so as to avoid irritation by pressure on a single tooth, or on one side of jaw.

As an incident in connection with the construction of the bridge, when working on the third molar, the patient related his experience in having had a gold filling put in on the buccal surface of this tooth by one of our late esteemed friends in New York City, which required a little more than an hour in the preparation of the cavity and insertion of the filling, and for which he paid two hundred and fifty dollars.

Since that occasion, he said, he had often wondered for what purpose he had preserved this third molar, as it was really not of much use to him, the two teeth in front of it having been lost; but now he realized why it had been preserved to advantage, because it enabled him to have this bridge put in, using the tooth as one of the abutments.

SECTION II.

DENTAL EDUCATION, LITERATURE, AND NOMENCLATURE.

REPORT BY LOUIS OTTOFY, CHAIRMAN OF THE SECTION.

MR. PRESIDENT AND GENTLEMEN: The Section on Dental Education, Literature, and Nomenclature begs leave to offer the following as its annual report:

I. Education.

Since 1887 this Section has regularly reported the number of dental colleges in active operation in the United States, with such additional information as has been deemed proper.

The list of dental schools is divided into two classes:

1. Dental colleges in active operation.
2. Dental colleges organized during the past year.

The following is the number of "Students in Attendance," and "Graduates," as reported by each school for the session of 1896–7:

1. Dental colleges in active operation.

	ATTENDANCE.	GRADUATES.
ALABAMA:		
*Birmingham Dental College, Birmingham	32	7
CALIFORNIA:		
†College of Physicians and Surgeons, Dental Department, San Francisco	107	5
*University of California, College of Dentistry, San Francisco	158	43
COLORADO:		
†Colorado College of Dental Surgery, Denver	10	0
*Denver College of Dentistry, Department of the University of Denver	27	8

	Attendance.	Graduates.
District of Columbia:		
*Columbian University, Dental Department, Washington	55	11
*Howard University, Dental Department, Washington	22	4
*National University, Dental Department, Washington	50	9
Georgia:		
*Atlanta Dental College, Atlanta	210	50
*Department of Dentistry, Southern Medical College, Atlanta	78	19
Illinois:		
*Chicago College of Dental Surgery, Chicago	469	142
*Columbian Dental College, Chicago	77	12
*Northwestern College of Dental Surgery, Chicago	57	16
*Northwestern University Dental School, Chicago	505	129
Indiana:		
*Indiana Dental College, Indianapolis	183	54
Iowa:		
*Dental Department, State University of Iowa, Iowa City	183	31
Kentucky:		
*Louisville College of Dentistry, Louisville	158	37
Maryland:		
*Baltimore College of Dental Surgery, Baltimore	210	63
*Dental Department, Baltimore Medical College, Baltimore	43	6
*University of Maryland, Dental Department, Baltimore	200	62
Massachusetts:		
*Boston Dental College, Boston	191	57
*Dental Department of Harvard University, Boston	131	32
Michigan:		
*University of Michigan, College of Dental Surgery, Ann Arbor	194	49
*Detroit College of Medicine, Department of Dental Surgery, Detroit	81	24
Minnesota:		
*University of Minnesota, College of Dentistry, Minneapolis	95	28
Missouri:		
*Kansas City Dental College, Kansas City	103	39
*Western Dental College, Kansas City	172	52
*Dental Department Marion-Sims College of Medicine, St. Louis	61	15
*Missouri Dental College, St. Louis	101	20
Nebraska:		
†Dental Department, University of Omaha, Omaha	47	3
New York:		
*Dental Department, University of Buffalo, Buffalo	199	67
*New York College of Dentistry, New York City	248	82
*New York Dental School, New York City	45	10
Ohio:		
*Cincinnati College of Dental Surgery, Cincinnati	69	27
‡Miami Dental College, Cincinnati	9	0
*Ohio College of Dental Surgery, Cincinnati	189	50

	Attendance.	Graduates.
*Western Reserve University, College of Dentistry, Cleveland	86	31
*Ohio Medical University, Department of Dentistry, Columbus	69	21
PENNSYLVANIA:		
*Pennsylvania College of Dental Surgery, Philadelphia	328	101
*Philadelphia Dental College, Philadelphia	408	138
*University of Pennsylvania, Department of Dentistry, Philadelphia	366	98
†Pittsburg Dental College, Department of Western University of Pennsylvania, Pittsburg	108	5
TENNESSEE:		
*Tennessee Medical College, Department of Dentistry, Knoxville	16	7
*Central Tennessee College, Meharry Dental Department, Nashville	17	6
*University of Tennessee, Dental Department, Nashville	71	14
*Vanderbilt University, Dental Department, Nashville	161	42
VIRGINIA:		
*University College of Medicine, Department of Dentistry, Richmond	29	7
WASHINGTON:		
*Tacoma College of Dental Surgery, Tacoma	25	4
WISCONSIN:		
*Milwaukee Medical College, Dental Department, Milwaukee	76	21
Total	6529	1758

*Member National Association of Dental Faculties.

†Application for membership in National Association of Dental Faculties received.

‡Announces that it will conform to the rules of the National Association of Dental Faculties.

2. New schools organized during the year, in which no sessions have been held:

PENNSYLVANIA:

‡Medico-Chirurgical College, Department of Dentistry, Philadelphia.

INDIANA:

‡Central College of Dentistry, Indianapolis.

IOWA:

‡Keokuk Dental College, Keokuk.

TOTAL.

1. Dental colleges in active operation	49
2. Organized during the past year	3
	52

According to these statistics there was an actual attendance of

6529 in the dental colleges of the United States, upon 1758 of whom the dental degree was conferred.

The following table indicates the increase in the number of graduates since 1886:

	For the Year.	Grand Total.
1886	503	
1887	597	1100
1888	746	1846
1889	796	2642
1890	963	3605
1891	1241	4846
1892	1483	6326
1893	379*	6708
1894	905*	7613
1895	1208	8821
1896	1446	10,267
1897	1748	12,015

*The decrease in 1893 and 1894 was due to the operation of the three-year course.

It is deserving of mention that every college now actively engaged in teaching, or which has been organized during the year, is either a member of the National Association of Dental Faculties, has an application for membership pending, or has made the announcement that it will comply with the rules thereof.

The Section has no further report to make on Dental Education.

The report on Dental Literature and Nomenclature will be made by Dr. Guilford, Secretary of the Section, and Chairman of the Special Committee on Terminology.

SECTION II.—Continued.

Dental Literature.

REPORT BY S. H. GUILFORD, SECRETARY OF THE SECTION.

AMONG the works relating to our specialty that have appeared since our last meeting, two are especially worthy of notice,—one the "American Text-Book of Prosthetic Dentistry," edited by Prof. C. J. Essig, and its companion work, the "American Text-Book of Operative Dentistry," edited by Prof. E. C. Kirk.

Each of these works represents the collaborative effort of a number of American writers, most of them professors in dental colleges belonging to the National Association of Dental Faculties, and all of acknowledged ability in their several departments.

Your Committee has also had brought to its notice, by the publishers, several works on branches related to our specialty. Two of these relate to the subject of chemistry. One, Luff's "Manual of Chemistry," seems to be one of the best works yet published upon the subject. It is full, complete, concise, and well arranged, but it is evidently written for the medical student, and not the dental.

On the other hand, the fourth edition of Mitchell's "Dental Chemistry and Metallurgy," which has appeared during the year, is especially adapted for students of dentistry, inasmuch as it gives the uses and properties of each substance in their relation to dentistry. It, however, seems to us to be too diffuse in its treatment of the subject, and contains much which, while valuable as information, does not come directly within the province of chemistry. Much of the matter is duplicated in works on prosthetic dentistry.

Schafer's "Histology," fourth edition, is an admirable treatise upon the subject, and is concise, complete, and clear. Abbott's

"Bacteriology," third edition, is evidently a working manual for the laboratory, but the author's treatment of the subject is so satisfactory as to constitute it, in the minds of your Committee, the best small work upon its subject yet published. Gray's "Anatomy," long a standard text-book, has recently been revised and brought into harmony with recent views on histology. Its treatment of dental anatomy, particularly, is worthy of praise, and the photo-lithographs and colored plates add to its value.

Burchard's "Compend of Dental Pathology and Therapeutics," while only a compend, contains the generally accepted teachings of to-day upon those branches, and has been favorably received.

Hodgen's "Dental Metallurgy," a new work upon its subject, is so excellent in its character and so admirable in its arrangement and treatment of the subject as to constitute it a model book for both student and practitioner.

Marshall's "Injuries and Surgical Diseases of the Face, Mouth, and Jaws," just published, is the latest contribution in the department of "oral surgery." The author treats his subject clearly, fully, and concisely in a number of short chapters, thus aiding the student in his attempt to grasp and retain the leading facts and principles set forth.

Your Committee has had its attention called to Duane's "Students' Medical Dictionary," and, while it appears to be an excellent work for the medical student, it would prove very inefficient for dental use. In it words with both a medical and dental meaning are given only the medical, while other words with almost or exclusive dental meanings are not given at all.

The dictionary which at the present time contains more words and definitions relating to our specialty than any other is Gould's "Medical Dictionary."

During the year new editions have been issued of Richardson's "Mechanical Dentistry" and Evans's "Crown- and Bridge-Work." Both of these works are well known to the profession through previous editions.

A small work on "Tin" has recently appeared from the pen of Dr. H. L. Ambler, of Cleveland. It is a very full and complete treatise upon the subject, and seems to contain about all that can be said at this time upon the valuable properties and methods of manipulating this metal in the filling of teeth.

SECTION III.

OPERATIVE DENTISTRY.

The Amalgam Question.

PAPER BY J. N. CROUSE, OF THE SECTION.

THE exact date when a combination of different metals reduced to a plastic state, with mercury, was first used as a filling-material in decayed teeth is not known to the writer; but the fact that amalgam has been a subject of constant dispute for the last thirty-five years, and that frequently during this time these controversies have been so vigorous as to destroy personal friendship and rupture the harmony of dental associations, and the additional fact that the questions under dispute are not settled, is sufficient proof that there are elements of uncertainty about amalgam and its use in dentistry which are more than trivial.

The careful and conscientious operator cannot but have had a feeling of distrust and uncertainty in the use of this much-employed material when he examined carefully, from all standpoints, the results of the many amalgam fillings which every active dentist has had an opportunity to see. My use of amalgam has been very limited, on account of the unfavorable results from its use by all classes of operators. Whether performed thoroughly or in the most careless manner, the fillings of amalgam in the mouths of the human family are far from satisfactory. The fact that the ravages of decay in many mouths continue and make fresh attacks beyond good fillings where the tooth-substance is left exposed, and the causes which induced decay in the first instance are still present, prevents good fillings and good filling-material from being distinguished from poor and imperfect fillings

and worthless material. Even good gold fillings in unfavorable conditions often fail to accomplish what was expected, and this fact prevents a complete detection of careless and imperfect operations when this one reliable material is used.

From this line of reasoning, what is the stimulus to encourage the best efforts when using what ranks as the second best filling-material employed by the dental profession, when out of sixty-odd different preparations of alloy, accurately tested, not one met all the requirements for a good filling-material? These faults and defects have always been known to exist, and efforts have been made to detect which one of the great number of amalgams offered for our use was the least objectionable; or, stating it in another way, which was the best offered. Filling cavities in ivory, tooth-brush handles, or glass tubes, and then immersing in some colored fluid which would indicate the leakage, and various other tests, have been employed, but we are indebted to Dr. Black for the first scientific method of testing amalgam. By the invention of a micrometer and dynamometer he was able to take accurate measurements and discover something of what occurred after amalgam was mixed and placed in cavities, and to determine scientifically their value; also, to some extent, what changes took place in amalgam fresh cut and after it had been what is known as "aged." The dental profession is indebted to this scientific investigator for many valuable facts brought out and many fallacies corrected, but we feel justified in the statement that the profession owes him a debt of gratitude for this work more than for any other.

While I have been able to confirm many facts brought out by Dr. Black, it is not my intention to review what he has done, as it has already been published, but rather to supplement and with similar implements to take up other lines of work which are much needed. *First.* To make tests of the amalgams now in general use, and give the results to such as are entitled to them. This, I trust, will prove beneficial not only to us, but to our patients as well. *Second.* To show, by the same aids, that we do not know how to use amalgam when a good one is furnished, and I hope thereby to get more thought and skill developed in its use. I have gone far enough in this work to make a radical statement, —namely, that the manufacturers are putting together metals

without the necessary equipment or the essential knowledge of the laws of metals and their relation to each other. At any rate, I will agree to prove that the amalgams on the market, as a rule, are unreliable and not uniform—lacking the essential qualities for a good filling-material. The study of this question has so absorbed my thoughts and aroused my energies that I can no longer hold them in check. Let me present the picture to your view. A profession that boasts of its accurate attainments, and which has the reputation of having made more rapid advancement than any other, is without any means of knowing the quality or behavior of the material, when placed in the cavities of teeth, that is more used by it than all others combined. Hence the dentists at the present time are almost helpless in making a selection from the great variety of amalgams on the market, the choice being entirely guesswork with them. I make this statement with evidence to sustain it beyond question of doubt, for the tests of amalgam cannot be made, either in or out of the mouth, without an elaborate and expensive outfit and an expenditure of much time and careful work, so that in selecting an amalgam a simpler method must be found.

Since starting these investigations I have had unusual opportunities to ascertain what amalgams the profession were using, and I have found the very poorest in the hands of some of the best operators. In one brand especially it would be hard to find any less desirable qualities, yet this amalgam I found in more first-class dentists' offices than any other. The answer from dentists as to why they had selected this or that amalgam demonstrated the fact that they had no idea what working qualities it must possess to be fit for use. Most practitioners demand that an amalgam shall be very plastic, be easily mixed, and require but little mercury, yet the exact opposites of these qualities characterize a good alloy. The use of plastic amalgam is a great mistake, for it is impossible to pack it perfectly in a cavity. This is readily demonstrated by manipulating under a magnifying glass, when the mass will be seen to move or shift from one side to the other, working like molten metal.

Another mistaken notion is, that an alloy is injured by manipulation after it commences to set. The exact opposite is true, for a stronger and better mass can be made if the amalgam be prop-

erly handled and put to place by heavy hand-pressure, or by malleting after it has fairly begun to set. This may not hold true with all varieties, since my experiments and investigations have been confined to one preparation, but it will be generally found true.

The third fallacy, accepted by very many, is that the least amount of mercury possible to make the mass pliable is the correct manner of mixing, but in this case again the opposite is true. The greater amount of mercury that can be incorporated into an alloy without squeezing out any surplus, when reasonable pressure is applied, the stronger the filling will be. An amalgam which is easily mixed is generally recommended, when exactly the opposite is evidence of a good alloy.

I have brought with me the micrometer, two kinds of dynamometers, and other implements, and invite inspection and practical tests with a variety of amalgams I have procured. In this way I hope to arouse more than usual interest in this important subject, although all the tests cannot be completed, as some amalgams will shrink and expand so much that the readings will show changes for many days; and the blocks of some will not harden enough to test their exact characteristics as to stress and flow in twenty-four hours, or even in forty-eight hours. However, many essential qualities can be shown while we are here, and I hope the benefits gained by those listening and taking part will be as great as the pleasure I have derived from this work.

DISCUSSION.

DR. PATTERSON: I wish to say a word or two in regard to Dr. Crouse's very interesting paper. He says that the alloys upon the market do not exhibit the same peculiarities in different mixings. I wish to say that it is my opinion—and I think it is the correct one—that alloys will exhibit the same results if they have been uniformly treated, and that is where the trouble is. Dr. Crouse, so far as appears from his statements before the Association, at least, does not commence on a basis which gives any value to his experiments,—that is, comparatively little value. So long as these different mixings of amalgam are made with different amounts of mercury and alloy, they will forever be different. He must commence on the basis of making the mixture with a definite

amount of mercury and alloy, which is the proper amount, before these experiments will be of any value whatever. That is the statement I wish to make, and I think I am practically and scientifically right. Unless we can begin on that basis, what is the use of taking different alloys, mixed by different people, in a variety of ways, with different amounts of the materials, and experimenting with them? It only proves what one man or another does, and gives us nothing of scientific value. I have as much respect as any one for the experiments of Dr. Black, which have been alluded to, but when Dr. Crouse says that Dr. Black was the first one to make those experiments with the micrometer and other instruments he is certainly mistaken, because history tells us that many years ago Thomas Fletcher, F.C.S., of Warrington, England, made all these experiments, or at least the important ones, on the same lines.

I am very much interested in alloys, and I am very much interested in having some settled and definite way of treating the various makes of alloy which produces a definite result. It can be done in the way I have indicated. Taking the alloys on the market, it is true that some of them require different amounts of mercury mixed with the mass of shavings or alloy; but let each be treated upon a scientific basis. When you find out the weight of alloy and mercury that makes a perfect amalgam, you should adhere to that proportion. It should be the amount of mercury and alloy which, when put in a filling, under pressure, will give a harmonious relation, a perfect amalgamation, without any excess of mercury. When any excess of mercury is expressed, then the whole alloy is jeopardized, because it has been changed from what the manufacturers put out. I believe that the standard alloys are very carefully tested. I know that some of them are; not only every ingot, but different portions of every ingot are tested thoroughly, and if they are not up to the standard they are not sent out. One package acts the same as compared with another if it is treated the same. Of course, if the manufacturers take sufficient care, and if the materials are treated scientifically, on the basis I have spoken of, *the results will be uniform.* I have told Dr. Crouse in private, and I tell him here, that I will take, not twelve samples of amalgam, as he stated, but twelve times twelve, mix them up, and put them in his forms, and they will practically give the same

results under his instruments. I am ready to do that here, or at any time. The instruments with which I work are not here, or I would gladly do it now.

DR. TAFT: There are so many phases of this subject that I scarcely know what to present in reference to it. These experiments, of course, are very interesting, and it is to be hoped that from other and like experiments something more may be derived than has yet been found by any one. I have not experimented extensively or minutely with this material. There are certain facts which I know about it. One thing which I may mention is the variation in behavior of all such alloys, especially those into which mercury enters. Even the alloys into which mercury does not enter are more fickle in their behavior than the pure metals. The more metals there are in an alloy the greater variety of behavior, and this is vastly increased when mercury is added. It is very apparent to one who has looked in that direction; and this, by the way, is an important matter. Many times we choose the direction in which we wish to look, and we look only in that direction for peculiarities and conditions. We may all have views, desires, and opinions that will direct our research. I have endeavored, without prejudice, to note the peculiarities and variations that are manifested in the admixture of the metals which are employed in the preparation of amalgams. The different varieties of amalgam will vary. But then, taking the same proportions of the same alloys with pure mercury, maintaining the proportions as precisely as possible, and manipulating them as nearly as possible in the same manner, they will, when placed in the mouth, give varying results. I have occasionally seen an amalgam give apparently good results in the preservation of teeth. I have seen the same amalgam, when placed in another mouth, utterly fail. It may be said that this is dependent upon the mode of manipulation, and that in different mouths it is subjected to varying influences, depending upon the degree to which the mouth is kept clean, and depending upon the secretions, whether they are normal or abnormal. All these things must be taken into account, in order to make an accurate estimate of the results to be attained by any preparation that will vary in the mouth, and that is likely to be acted upon by the agents that may be present in the mouth. The mouth is a very severe test for anything that is liable to change. The fluids of the mouth are very

complex. There is a great variety of reactions and conditions. They are subjected to constant variations, and whatever is placed in the mouth is subjected to very active agents. Now, it is true that in some mouths the standard amalgams may be used, and seem to serve well the purposes for which they are employed. The same materials, placed in another mouth, will promptly show oxidation, and under other circumstances will show contraction, while in other instances they will not show contraction. It is this variation in behavior which constitutes one of the great objections to the use of amalgams. The manipulation, the manner of treatment, is of course a matter upon which much depends. That is illustrated in the use of oxyphosphates. We may take almost any oxyphosphate that is reasonably good, and the results are very greatly modified by the manner in which it is manipulated. Discussion has been had upon the liability of oxyphosphates to fail under the margin of the gum. In some instances I have seen oxyphosphates stand just as well under the margin of the gum as anywhere else, this dependent upon the quality of the material, manner in which it was manipulated, together with the conditions that existed in the mouth. I know just as well that in many other cases, as you all know, it fails in a very little while.

In regard to amalgam, my objections to it are: The liability to shrinkage, the liability to changed form, the liability to decomposition and oxidation, or union with any other material for which it may have an affinity that may come into the mouth. In setting or solidifying, varying conditions will be apparent. In breaking some specimens of amalgam it will be found that they are dense and others quite porous and soft, in which event the material is unfit for filling teeth. In setting or solidifying, amalgams will often show crystallization, more or less perfect, but in some cases an entire absence of crystallization, or rather a granular mass, into which, if the granules are large, moisture will penetrate.

My attention was directed to this in the first place, more particularly when I experimented in the preparation of crystal gold for filling teeth. I found that in many instances the same gold, with the same reagents, manipulated as nearly as possible in the same way, would present a variety of results. Sometimes gold will be formed with very perfect crystals; sometimes with

small and sometimes with large crystals, and in other cases there would be none at all, but a mere granular mass that had no more cohesion than grains of sand; and in some cases where there was perfect crystallization there would be strong cohesion, while in other cases the crystals would have no cohesion at all. How shall we account for these variations? It was not in the manipulation, not in the character of the materials used. I came to the conclusion that the environment, atmospheric condition present at the time of the manipulation influenced the results. Under certain conditions of the atmosphere it was impossible to get the desired results, so far as crystallization was concerned. On a clear, bright day, in cool weather, better preparations would be made. On a dark, lowering day the result would be very different indeed, and it was almost impossible to develop the cohesive property of the crystals under such an atmospheric condition. I have no doubt that the atmospheric and electrical conditions have much to do in causing these different results.

I have yet to make the first amalgam filling in a tooth in the mouth. My experiments forty years ago led me to the conclusion that it was not a reliable material, and I could not conscientiously use it. No doubt I might have used it and thereby have saved many teeth, but I know full well that, had I made general use of it, there would have been many failures, more failures than are experienced in the use of other, and I think better, materials. For this reason I have never used it. I advise against it, because of these things. I always advise against anything that I cannot conscientiously use. I do not like any one to keep silence when he has conscientious scruples against anything which is receiving general attention. Express your convictions in regard to every important subject advanced. If Dr. Crouse brings out a preparation in which these difficulties and objections do not appear, and are not likely to occur, I should be glad to use amalgam, but under existing circumstances I have never found the way clear to use it.

DR. CUSTER: A slight oxidation of an amalgam filling is the best thing that can happen to it; not oxidation to blackness, but to a tarnish. That is practically the same thing as the polarization which takes place in galvanic cells and the galvanic action is stopped. So I believe that oxidation is one of the best things that can happen to an amalgam filling.

DR. PEIRCE: Dr. Patterson was certainly correct. It is a law of nature that similar things, being similarly operated upon, must bring a similar result. It can be nothing else. Now the question comes, when we arrive at a definite conclusion with regard to the amount of mercury for a certain alloy which is best adapted to make an amalgam, then shall we not in the future have those placed in a capsule, to be used together, so we may definitely get at the proper mixture? Then comes the amount of trituration. That also varies. There are scarcely two operators who take these materials, the mercury and the alloy, and triturate them for the same amount of time; so that, having the given amount of alloy and the given amount of mercury, you should have a uniform amount of trituration to bring about a given and uniform result, because a variation in either one will cause a variation in result. Then, as Dr. Taft has said, we place them in different environments. We do not find two patients where the filling goes into the same environment. That must also have an influence upon its subsequent history. It is very difficult indeed to use a plastic material in a mouth and have uniform results, for the reason stated; the conditions under which it is used are so variable. If we can get down to the facts in each case, and insure uniform action in every particular, then we shall always have uniform results. We can approach uniformity, however, by always having the correct proportions of alloy and mercury. The rest is, as I said, uncertain, because we never can tell as to the conditions of the environment which surround it, or under which it hardens. So we shall have a somewhat varying result, because we cannot control that.

The PRESIDENT: Dr. Crouse, will you close the discussion on this subject?

DR. CROUSE: I will close it for the present very quickly, but I do not expect to close it finally for some time. I think that some of Dr. Patterson's propositions are correct. I well remember reading something about the experiments of Fletcher, and shall take them up again to see what they were. I was not aware that he had taken this same line of experiment. If we once settle on the correct combinations of metals, treated properly to zero, so they will stay as you put them in any ordinary atmosphere, be the strongest, and not shrink or expand, then there is another

important question not yet settled. It cannot possibly be profitable to teach every dentist how to make his own amalgam, but he should learn how to manipulate it. That was what I tried to bring out,—the manipulation. It has not been settled by those who have made the most accurate tests whether squeezing the surplus of mercury out of the alloy is better or not. The strongest blocks that I have made thus far have been amalgams that would mix, and that you could pack without squeezing out the surplus mercury. Yet I have made some very good ones by putting in a surplus of mercury and then squeezing it quite dry with a towel or chamois and packing it. That is certainly better than the way the average practitioner mixes his amalgam. If he will adopt that rule he will get the most uniform results, unless he weighs out the proper proportion of mercury and alloy and then mixes. I believe the most satisfactory amalgam to the careful man will be the one that is settled by definite experiment. What will be the strongest? Which will flow the least? Then he should have the mercury put into one capsule and the alloy into another, and have those go together as the proper amount, so nothing will squeeze out.

Then comes the other matter,—how to pack it. I have made but few tests of the blocks we have here. One would not stand a stress of fifty pounds. Another stood 400 pounds, and both were made of the same alloy and mixed as they would ordinarily be mixed, without saying particularly who mixed them. We had that much variation in the manipulation here. Then add to that the variation in the alloys, and is it any wonder that the careful observer has many times become disgusted with amalgam fillings?

DR. TAFT: Add to that the variations in the environment.

DR. CROUSE: Yes, add to that the variations in the environment. But as to the proposition of Dr. Patterson, that he has found his alloys running uniform, I can say only that either he has been more fortunate than I have, or his tests have not been so accurate. I place considerable stress on the last statement, and will guarantee to prove it to him if he will pick up, as I have, the same make in different offices and make the same tests. I could convince him that alloys are not uniform and nothing like uniform. In all the experiments I have scarcely ever found two specimens of the same make—that is, bearing the same label—

that were uniform. Whether it is in the melting together of the metals, or the treatment afterward, I do not know, but think it is the latter. I could name a combination in which the burning out of one ingredient in one hundred will entirely alter the character of the result, under a scientific test. You can perhaps tell a little something about it by fingering it, but that does not compare with a test which assures the keeping out of micro-organisms between the filling and the tooth-substance. It is amazing to me that amalgam has done as well as it has, and the result of my experiments confirms the uncertainty that I have felt with regard to amalgam fillings in the last thirty years.

I believe the proper way to put an alloy on the market will be with the mercury weighed out, when we ascertain what the proper proportion is. It certainly would be safe to say that it should be made so plastic as to handle well, and the alloy ought to hold just so much mercury as it will without squeezing out a surplus. Furthermore, I believe it is a mistake to be afraid of packing the alloy after it begins to set, for the best results are obtained when that is done.

FINAL REPORT OF TREASURER.

NASHVILLE, Tenn., April 12, 1898.

HENRY W. MORGAN, Treasurer, in account with the American Dental Association.

Dr.

Balance on hand at last report	$1590.34
Dues collected at Old Point Comfort	670.00
Dues collected since	595.00
	$2855.34
Paid out	1979.01
Balance on hand April 12, 1898	$876.33

Cr.

EXPENDITURES.

Salary Secretary, 1897	$300.00	
" " 1898	300.00	
" Treasurer, 1897	100.00	
" " 1898	100.00	
Reporter Session 1897	125.00	
Expenses Executive Committee, 1897	209.60	
Advanced Protective Association, October, 1897	200.00	
The S. S. White Dental Mfg. Co., Transactions, 1896	52.84	
" " " " " 1897	75.92	
Committee on Union	42.56	
Committee on National Museum	40.00	
Committee on Nomenclature	3.00	
Publication Committee	53.59	
Section IV	18.00	
Section VII	65.90	
Corresponding Secretary, printing and postage	17.75	
Incidental expenditure, Publication Committee, 1897	1.10	
Printing, postage, stationery, and exchange, Treasurer	24.75	
Treasurer National Dental Association, $1.00 for 249 members	249.00	
Total	$1979.01	$1979.01

The above is the balance on hand to-day, and this balance is due the Protective Association, less two hundred and fifty ($250) dollars subscribed conditionally to the Wells Memorial.

Respectfully submitted,
HENRY W. MORGAN, *Treasurer.*

Audited and found correct,
V. H. JACKSON,
H. A. SMITH,
LOUIS OTTOFY,
Auditing Committee.

FINAL REPORT OF THE PUBLICATION COMMITTEE.

The Publication Committee would respectfully submit the following report:

The Transactions were published as usual by The S. S. White Dental Manufacturing Company, with an Appendix containing the transactions of the National Dental Association.

All copy was in the custody of the publishers on the 14th of October, 1897, which should have insured their distribution by mail not later than the 10th of January, 1898; but for some unexplained reason they have been delayed to this late day.

They have been mailed to those entitled to them, including societies and libraries; and the few copies printed in excess of those necessary for this purpose have been placed in the Army Medical Library at Washington.

In accordance with the instruction of the Association, all copies of Transactions on hand were forwarded to the Army Medical Museum, with the rebound book containing the original constitution and signatures thereto; also the engraved gavel, the bound volumes of business minutes, and the book containing the signatures of those members present at the final dissolution of the Association.

This brings all the business of the Association, including the final meeting and the closing up of its affairs after its dissolution, within this report.

RECEIPTS AND EXPENDITURES.

Received from Treasurer		$53.59
Expended for expressage	$4.50	
Copying and engrossing	18.00	
Paper and envelopes	6.25	
Postal cards	1.50	
Postage	11.00	
Boxing and packing books for Army Medical Library	3.00	
Freight and cartage nine boxes books to Washington	3.09	
Binding old constitution and last minutes	3.75	
Engraving gavel	2.50	
		$53.59

GEORGE H. CUSHING,
Chairman Publication Com.

Audited and found correct,

V. H. JACKSON,
LOUIS OTTOFY,
H. A. SMITH,
} *Auditing Committee.*

APPENDIX.

Minutes of the Organization and Transactions of the National Dental Association.

MINUTES OF THE CONVENTION RESULTING IN THE FORMATION OF THE NATIONAL DENTAL ASSOCIATION.

By W. E. WALKER.

OLD POINT COMFORT, Aug. 5, 1897.

THE members of the American Dental Association and of the Southern Dental Association met in convention in the ballroom of the Hygeia Hotel, Old Point Comfort, Virginia, at 2.30 P.M., on Thursday, August 5, 1897, for the purpose of forming a new dental association, through the union of the American and Southern Dental Associations.

Dr. Thomas Fillebrown, Chairman of the Committee on Union of the American Dental Association, called the convention to order. Dr. John B. Rich, of Washington, D. C., was chosen Chairman, and Drs. W. E. Walker, of Pass Christian, and Geo. H. Cushing, of Chicago, were chosen Secretaries.

Dr. J. D. Patterson introduced the following resolution, which was adopted:

Resolved, That the members of the American Dental Association and the members of the Southern Dental Association do hereby organize themselves into a body to be known and styled the National Dental Association.

The following resolution was offered by Dr. Marshall:

Resolved, That the Constitution, By-Laws, and Rules of Order, decided upon and presented by the joint committee of these two bodies be and are hereby adopted as the Constitution, By-Laws, and Rules of Order of the National Dental Association.

Before this motion was put the following, introduced by Dr. Richards, was after some discussion adopted:

Resolved, That no speaker shall occupy the floor for more than three minutes without the consent of a majority of this body.

Dr. Marshall's resolution was then adopted.

Dr. Brophy moved that we proceed to the election of officers.

Dr. Taft moved a reconsideration of the action by which the Constitution was adopted.

After discussion, Dr. Taft, with the consent of his second, withdrew his motion.

Dr. C. N. Peirce moved that the committee which formulated the Constitution and By-Laws make nominations for officers for the coming year, to be presented to the convention for its action.

Dr. H. E. Beach pointed out the provision of the Constitution requiring that nominations be made by informal ballot.

Dr. L. Ottofy moved that Dr. Brophy's motion be laid on the table. So ordered.

Dr. E. P. Beadles moved that the Secretary read the Constitution and By-Laws, which motion prevailed, and they were read by the Secretary.

Dr. Ottolengui moved that Dr. Brophy's motion be taken from the table, and that we now proceed to the election of officers, which motion prevailed, and Drs. Hunt and Noble were appointed tellers.

On the informal ballot, Dr. Fillebrown receiving fifty-one out of ninety-two votes cast, the informal ballot was made formal and Dr. Fillebrown was declared the President of the National Dental Association.

Dr. Richards, the retiring President of the Southern Dental Association, and Dr. Truman, the retiring President of the American Dental Association, were appointed to escort the newly-elected President to the chair.

It was voted to take a recess for dinner, to reconvene at 4.30 P.M.

NATIONAL DENTAL ASSOCIATION.

FIRST MEETING.

The Association was called to order at 4.30 P.M., pursuant to adjournment, by the President, Dr. Fillebrown.

The election of officers was proceeded with.

On motion it was decided to ballot for the Recording Secretary before any other officers.

Drs. Hunt and Noble were appointed tellers. Dr. Geo. H. Cushing, of Chicago, was elected.

Dr. Cushing here assumed his duties, and the minutes from this to the close of the session are by him.

On motion of Dr. Crawford, by unanimous consent, it was decided to appoint an Assistant Secretary.

On motion of Dr. Peirce the Secretary was instructed to cast the vote for W. E. Walker for Assistant Secretary.

Proceeded to ballot for Vice-President for the East.

On motion the Secretary was instructed to cast the vote for Dr. James McManus, of Hartford, who was thus duly elected.

Balloting for Vice-President from the West resulted in the election of Dr. L. L. Dunbar, of San Francisco.

The ballot for Vice-President from the South resulted in the election of Dr. B. Holly Smith, of Baltimore.

On motion, the Secretary was instructed to cast the ballot for Dr. Emma Eames Chase for Corresponding Secretary.

The Secretary was instructed by vote to cast the ballot for Dr. H. W. Morgan, of Nashville, for Treasurer.

Dr. Beadles, of Virginia, moved that the President cast the ballot for the entire Executive Committee. Carried.

The following were elected:

For the South, L. G. Noel, M. F. Finley, and George Eubank; for the West, J. N. Crouse, W. P. Dickinson, and J. D. Patterson; for the East, C. N. Peirce, H. A. Smith, and V. H. Jackson.

Drs. Eubank, Dickinson, and Peirce serve for one year, Drs. Finley, Patterson, and Smith for two years, and Drs. Crouse, Noel, and Jackson for three years.

The selection of place of next meeting now being in order, Denver, Omaha, and Minneapolis were nominated. Omaha was selected.

The following resolution was adopted:

Resolved, That the Treasurer of this Association be directed to request the Treasurers of the American Dental Association and of the Southern Dental Association to furnish him with the lists of the permanent members of their respective Associations, and he is hereby directed to add the names so furnished him to the Constitution of this Association as set forth in the provisions of membership in Article III, Section 5, of the Constitution; and be it further

Resolved, That said act of the Treasurer shall be legal and binding the same as if the signatures had been attached by the persons themselves.

The following was adopted:

Resolved, That a committee of three be appointed by the President of this Association to take into consideration the question of establishing a journal for the publication of the transactions of this Association and other original matter pertaining to dental surgery and the collateral sciences, and that they report to this body at the next annual meeting.

The following resolution was presented by Dr. Crawford:

Be it Resolved, That it is the sense of the National Dental Association that when any member of the dental profession, in good standing, presents a certificate of registration from any State in the Union, that the same should be admitted to registration in any other State without additional examination.

On motion, the President, Dr. Fillebrown, was authorized to have printed as many copies of the Constitution and By-Laws as he may deem necessary.

On motion, it was resolved that when we adjourn it shall be to meet to-morrow at 12 M., at the Chamberlin Hotel.

The following was adopted:

Resolved, That the two Associations participating in this organization be requested to contribute from their respective treasuries to the treasury of the National Dental Association the sum of one dollar per member for all members whose dues are fully paid; and in view of this contribution, the dues of all such members of the National Dental Association for the year 1897 shall be remitted.

The following resolution, offered by Dr. R. Finley Hunt, was adopted:

Resolved, That a committee of three be appointed by the President to report at the next annual meeting a measure looking to the preparation of a full history of the dental profession.

On motion, adjourned till 12.30 to-morrow.

Thursday Noon.

The Association met according to adjournment at 12.30; the President, Dr. Fillebrown, in the chair.

The minutes of yesterday were read and approved.

The following committees were announced:

ORGANIZATION OF THE EXECUTIVE COMMITTEE.—J. N. Crouse, *Chairman;* M. F. Finley, *Secretary.*

FIRST DIVISION. COMMITTEE OF ARRANGEMENTS.—J. N. Crouse, L. G. Noel, and H. A. Smith.

SECOND DIVISION. CREDENTIALS AND AUDITING COMMITTEE.—V. H. Jackson, J. D. Patterson, M. F. Finley.

THIRD DIVISION. COMMITTEE ON VOLUNTARY ESSAYS.—C. N. Peirce, W. P. Dickinson, George Eubank.

Publication Committee.—A. W. Harlan, V. E. Turner.

Committee on National Museum and Library.—Williams Donnally, H. W. Morgan, and T. Fillebrown.

Committee on Terminology.—S. H. Guilford, Grant Molyneaux, and S. W. Foster.

Committee on Journal.—J. S. Marshall, J. Taft, L. G. Noel.

Committee on History.—Charles McManus, R. Finley Hunt, and Gordon White.

The Sections were organized and finally completed as follows:

SECTION I. Prosthetic Dentistry, Chemistry and Metallurgy.—Grant Molyneaux, Chairman; R. R. Freeman, Secretary. W. S. Smith, Henry McManus, Louis C. Le Roy, Howard S. Seip, J. Hall Moore, George H. Wilson, P. J. Wilson, Herbert C. Miller, A. P. Johnstone, William Ernest Walker, William S. Hosford, George M. Whitfield, D. D. Smith, George Evans, J. N. Van De Water, J. Rollo Knapp, S. E. Gilbert, T. S. Waters, W. H. Fundenberg, C. Edmund Kells, Jr., H. S. Sutphen, S. A. Freeman, Jules J. Sarrazin, J. A. Hall, N. D. Edmonds, George W. Warren, J. Edwin Boozer, C. H. Frink, E. G. Quattlebaum, Ralph B. Reitz, J. V. Haller, T. M. Allen, S. W. Allen, H. L. Ambler, L. Augspath, J. W. Ayers, Boyd H. Baker, L. L Barber, U. D. Billmeyer, J. Adams Bishop, E.

A. Bogue, Alonzo Boice, H. H. Boswell, C. T. Brockett, I. N. Broomell, C. J. Essig, D. E. Everitt, George Eubank, W. H. Ewald, George L. Field, J. G. Fife, W. B. Finney.

SECTION II. Dental Education, Literature, and Nomenclature.—B. H. Catching, Chairman; M. F. Finley, Secretary. H. T. Smith, Jacob L. Williams, L. Ashley Faught, Eugene H. Smith, Charles McManus, Frank G. Gregory, Thomas C. Stellwagen, C. N. Peirce, S. H. Guilford, J. Hall Moore, Henry W. Morgan, J. Taft, William A. Montell, F. T. Murlless, Jr., C. D. Cook, Edward C. Kirk, D. D. Smith, L. D. Shepard, A. O. Hunt, S. E. Gilbert, H. S. Sutphen, B. D. Brabson, W. W. H. Thackston, H. H. Johnson, T. M. Allen, H. L. Ambler, L. L. Barber, J. Adams Bishop, E. A. Bogue, C. T. Brockett, A. J. Brown, H. J. Burkhart, C. S. Butler, Allen R. Carr, I. N. Carr, C. S. Case, J. S. Cassidy, W. G. Chase, C. C. Chittenden, Dwight M. Clapp, W. R. Clifton, S. B. Cook, W. H. Cook, J. P. Corley, L. M. Cowardin, T. E. Craddock, William Crenshaw, J. N. Crouse, G. L. Curtis, E. T. Darby, L. L. Dunbar, W. St. George Elliott, Charles J. Essig, George L. Field, W. H. Morgan.

SECTION III. Operative Dentistry.—J. Y. Crawford, Chairman; Frank Holland, Secretary. C. N. Johnson, Corydon Palmer, P. S. Bollinger, H. T. Smith, L. P. Bethel, S. Freeman, S. G. Perry, J. I. Hart, L. C. Taylor, W. S. How, Harvey Iredell, E. S. Gaylord, S. C. G. Watkins, A. J. Prosser, James McManus, Louis C. Le Roy, Charles K. Van Vleck, H. Barnes, A. H. Fuller, G. W. Hoysradt, W. E. Page, Howard S. Seip, S. H. Guilford, J. Hall Moore, P. J. Wilson, Earl P. Hawes, H. B. Tileston, William Conrad, S. B. Palmer, H. G. Ulrich, B. Eugene Holcombe, J. T. Lippincott, B. Holly Smith, Thomas T. Moore, J. Percy Corley, R. J. Hart, B. H. Baker, Thomas Fillebrown, Louis Jack, B. F. Luckey, D. D. Smith, G. L. S. Jameson, J. W. Meng, S. E. Gilbert, T. S. Waters, C. H. Harroun, W. F. Fundenberg, S. L. Goldsmith, H. S. Sutphen, Robt. I. Verplanck, B. Oscar Doyle, C. L. Alexander, Jules J. Sarrazin, W. Woolsey, C. S. Stockton, F. L. Wood, F. P. Welch, W. W. Shryock, M. B. Culver, V. E. Turner, I. Simpson, Thomas T. Moore, J. D. Pfeifer, A. R. Melendy, L. Augspath, J. W. Ayers, J. Adams Bishop, C. T. Brockett, A. J. Brown, H. J. Burkhart, C. S. Butler, C. R. Butler, Allen R. Carr, I. N. Carr, W. G. Chase, C. C. Chittenden, Dwight M. Clapp, W. R. Clifton, S. B. Cook, W. H. Cook, T. E. Craddock, William Crenshaw, J. N. Crouse, George H. Cushing, E. T. Darby, L. L. Dunbar, W. St. George Elliott, George L. Field, S. W. Foster, W. B. Finney, John E. Frazier, G. J. Friedrichs, Leo Greenbaum, Charles S. Grindall, O. J. Gross, T. S. Hacker, James H. Harris, J. S. Hardy, H. F. Harvey, Joseph Head, Thomas P. Hinman, J. E. Hinkins, D. M. Hitch, N. S. Hoff, Frank Holland, George E. Hardy, George E. Hunt, Robert Huey, Lee F. Huffman, Henry A. Hull, J. Searle Hurlbut, C. S. Inglis, Harvey Iredell, W. T. Jackman, F. A. Remington, B. J. Pressey, J. B. Pressey, J. W. Quattlebaum, C. B. Rohland, John B. Rich, W. E. Richardson, W. H. Richards, N. J. Roberts, D. N. Rust, B. Rutledge, R. M. Sanger, S. P. Sharp, N. T. Shields, A. H. Sibley, Charles Sill, H. H. Sisson, B. Holly Smith, J. W. Smith, H. A. Smith,

M. B. Straight, John F. Stephan, B. Q. Stevens, R. A. Talbot, J. G. Templeton, Henry C. Thompson, J. S. Thompson, J. L. Walker, R. H. Walker, W. E. Walker, William Wallace Walker, J. W. Wassall, W. C. Wendel, T. L. Westerfield, T. P. Whitby, J. H. White, T. C. Wilson, J. L. Wolf, G. F. S. Wright.

SECTION IV. Histology and Microscopy.—I. P. Wilson, Chairman; Thomas P. Hinman, Secretary. L. P. Bethel, Louis C. Le Roy, Charles K. Van Vleck, A. F. Sonntag, H. Jerome Allen, S. E. Gilbert, A. J. Brown, C. S. Butler, I. N. Carr, W. G. Chase, W. H. Cook, J. A. Dale, E. T. Darby, I. B. Davenport, J. W. David, B. Douglass, L. L. Dunbar, A. R. Eaton, Edward Eberle, Edward Eggleston, John E. Frazier.

SECTION V. Materia Medica and Therapeutics.—J. S. Cassidy, Chairman; L. P. Bethel, Secretary. A. W. Harlan, S. Freeman, James Truman, W. A. Price, Wilbur F. Litch, W. E. Griswold, S. E. Gilbert, A. H. Peck, C. R. Jefferis, A. R. Starr, H. S. Sutphen, M. W. Foster, N. S. Hoff, E. S. Holmes, B. E. Holcombe, George E. Hunt.

SECTION VI. Physiology and Etiology.—J. D. Patterson, Chairman; L. E. Custer, Secretary. W. S. How, L. Ashley Faught, Louis C. Le Roy, Emma Eames Chase, Thomas C. Stellwagen, M. L. Rhein, S. E. Gilbert, H. A. Smith, J. Howard Gaskill, J. Newton Giddens, A. H. Gilson, N. J. Goodwin, C. W. Granger, Leo Greenbaum, Meta T. Haley, R. Finley Hunt, Robert Huey, H. H. Jackson, H. R. Jewett, A. P. Johnstone, G. E. Johnson, R. H. Jones, Henry C. Jones, R. V. Jones, Victor S. Jones, H. H. Keith, R. N. Kesterson, A. B. King, Edward M. Kettig, Samuel E. Knowles.

SECTION VII. Anatomy, Pathology and Surgery.—W. C. Barrett, Chairman; George Clement, Secretary. John S. Marshall, L. P. Bethel, T. W. Brophy, J. D. Thomas, C. A. Brackett, Frank G. Gregory, W. H. Whitslar, M. L. Rhein, M. C. Smith, S. B. Dewey, Thomas Fillebrown, T. T. Hayward, A. O. Hunt, S. E. Gilbert, F. A. Shotwell, C. P. Pruyn, T. L. Gilmer, W. T. McLean, Thomas T. Moore, J. H. Benton, A. G. Friedrichs, H. A. Lowrance, J. Thomas Lippincott, John D. Loetzerich, B. F. Luckey, W. A. Lyons, R. Maercklein, E. B. Marshall, F. J. Maynard, Theodore Menges, W. H. Morgan, L. G. Noel, A. L. Northrop, J. E. Orrison, T. H. Parramore, F. A. Remington.

SECTION VIII. Hygiene and Prophylactic Dentistry.—W. T. Arrington, Chairman; A. H. Thompson, Secretary. Louis C. Le Roy, H. G. Ulrich, J. Taft, T. T. Hayward, S. E. Gilbert, Williams Donnally, F. H. McAnnally, H. C. McBrair, H. J. McBride, H. B. McFadden, George S. Nason, J. J. Nelson, H. B. Noble.

SECTION IX. Orthodontia.—V. H. Jackson, Chairman; L. P. Dotterer, Secretary. Louis Ottofy, L. C. Taylor, W. E. Grant, Louis C. Le Roy, Frank G. Gregory, R. Ottolengui, S. H. Guilford, M. C. Smith, J. W. Canaday, J. N. Van De Water, W. N. Cogan, C. L. Goddard, W. H. Fundenberg, Jules J. Sarrazin, L. D. Carpenter, Gordon White, H. E. Beach, C. S. Case, H. B. Noble.

SECTION X. Clinics. H. J. McKellops, Chairman; E. P. Beadles, Secretary. L. C. Taylor, William Conrad, M. B. Culver, J. Edwin Boozer, I. Simpson, S. Dickson.

The following standing resolution was adopted:

Resolved, That any member of the dental profession who has been in reputable practice for a period of fifty years may be elected to permanent membership in this Association without the payment of dues; and any member of this Association who has been in practice for a like period shall have his dues remitted thereafter by presenting the fact to the Treasurer of the Association.

The following was adopted:

Resolved, That the Committee on National Dental Library and Museum be authorized to seek in the interest of public health, at government expense, the appointment in the Army Medical Library and Museum of at least one dentist of eminent fitness, whose time when so employed shall be devoted to the advancement of dental science.

The following was adopted:

Resolved, That a committee of three be appointed whose duty it shall be to confer with State and local societies and to aid and foster new societies when and where desirable.

The President appointed as that Committee, J. Taft, J. Y. Crawford, and James McManus.

On motion of Dr. Crawford, the Association authorized the publication of all the proceedings of this body as a supplement to the transactions of the American and of the Southern Dental Associations.

The following motion prevailed:

Resolved, That a committee be appointed from this Association consisting of one member from each State and Territory, to work in the interest of the Dental Protective Association.

The Committee as named is as follows:

Alabama.—W. J. Reynolds, Selma.
California.—L. A. Teague, San Francisco.
Colorado.—P. T. Smith, Denver.
Connecticut.—C. P. Graham, Middletown
Florida.—W. A. McQuaig, Lake City.
Georgia.—J. A. Chapple, Atlanta.
Illinois.—J. A. Davis, Galesburg.
Indiana.—W. L. Rawls, Indianapolis.
Iowa.—K. M. Fullerton, Cedar Falls.
Kentucky.—J. H. Letcher, Danville.
Kansas.—J. P. Root, Kansas City.
Maine.—F. A. Burnham, Saco.

Maryland.—F. F. Drew, Baltimore.
Massachusetts.—W. E. Boardman, Boston.
Michigan.—A. W. Diack, Detroit.
Mississippi.—P. N. Wright, Senatobia.
Minnesota.—W. D. James, Tracy.
Missouri.—J. T. Fry, Moberly.
Nebraska.—J. S. McCleery, Beatrice.
New Hampshire.—W. R. Blackstone, Manchester.
New Jersey.—J. L. Crater, Orange.
New York.—H. J. Burkhart, Batavia.
North Carolina.—H. V. Horton, Winston.
North Dakota.—H. L. Starling, Fargo.
Ohio.—L. E. Custer, Dayton.
Pennsylvania.—W. F. Litch, Philadelphia.
Rhode Island.—E. P. Robinson, Newport.
South Carolina.—J. C. Oeland, Spartanburg.
Tennessee.—W. H. Richards, Knoxville.
Texas.—J. L. Buchanan, Bonham.
Vermont.—C. S. Campbell, St. Albans.
Virginia.—J. V. Haller, Wytheville.
Washington.—R. B. Gentle, Olympia.
West Virginia.—Robert Tever, Wheeling.
Wisconsin.—R. G. Richter, Milwaukee.

On motion, adjourned to 2 P.M.

Afternoon Session. Thursday.

Association was called to order at 2 P.M., the President in the chair.

The minutes of the morning session were read and approved.

The following notices of proposed amendments were filed:

By J. Y. Crawford,—

To change the name of this Association from The National Dental Association to The American Association of Dental Surgeons.

By Dr. Guilford,—

To change the name from that of National Dental Association to that of The American Association of Dental Science.

By Dr. Stellwagen,—

To amend Article I by striking out the words "National Dental" and inserting in their place the words "American Stomatological."

The minutes were finally read and approved, and the Association adjourned to meet at Omaha the first Tuesday after the last Saturday in August, 1898.

GEORGE H. CUSHING, *Secretary.*

CONSTITUTION AND RULES OF ORDER OF THE NATIONAL DENTAL ASSOCIATION.

PREAMBLE.

We, the members of the American Dental Association and of the Southern Dental Association, do declare ourselves a Society to cultivate the science of dentistry, and have adopted the following Constitution and Rules of Order for our government:

CONSTITUTION.

ADOPTED AUGUST, 1897.

ARTICLE I.

NAME.

This organization shall be known by the name of the National Dental Association.

ARTICLE II.

OBJECT.

The object of this Association shall be to cultivate the science and art of dentistry and all its collateral branches, to elevate and sustain the professional character of dentists, to promote among them mutual improvement, social intercourse, and good feeling, and collectively to represent and have cognizance of the common interests of the dental profession.

ARTICLE III.

MEMBERS TO BE OF THREE CLASSES.

SECTION 1. The members of this Association shall be of three classes, —viz, permanent, delegate, and honorary members; the two former classes having equal rights and privileges, except that none but permanent members shall be eligible to office.

PERMANENT MEMBERS.

SEC. 2. Permanent members shall consist of those who, coming as delegates and complying with the requirements of the Association, shall sign a statement in a book to be kept for that purpose signifying to the Treasurer a desire for permanent membership.

DELEGATE MEMBERS.

SEC. 3. All delegate members shall be practitioners of dentistry. They shall be received only from permanently organized State dental societies.

They shall be elected by ballot at some regular meeting of their society, and shall be members who have done some meritorious work for the profession; but no person shall be received as a delegate who is in arrears for dues to this Association.

SEC. 4. Honorary members shall consist of prominent worthy members of the dental profession residing in foreign countries, who shall be elected by ballot.

SEC. 5. It is hereby specially provided that all persons at present permanent members of the American Dental Association and of the Southern Dental Association are permanent members of this Association, and entitled to all the privileges of the class to which they belonged, without further action, and the Treasurer is hereby directed to transcribe their names upon the roll of membership of this Association.

ARTICLE IV.

DELEGATES FROM STATE SOCIETIES.

SECTION 1. Each State society may send one for every ten of its active members as delegates to this Association for one year, upon complying with the requirements of its Constitution; but no society shall be entitled to representation that does not adopt or substantially recognize the Code of Ethics of this Association.

SEC. 2. Each delegate shall present credentials which shall be approved by the Executive Committee.

SEC. 3. If the Committee on Credentials has knowledge that any applicant for membership is violating the Code of Ethics, said applicant shall not be received, but shall be referred by the committee to the societies whose delegates they are, and in no case shall this Association be compelled to treat with violations of the Code except the violator is a member of this body and has no membership in any local body.

SEC. 4. This Association will receive no delegates who, since August, 1875, shall have entered the profession without having first graduated at some reputable dental or medical college.

ARTICLE V.

SIGNING CONSTITUTION.

SECTION 1. Each new member, before voting or speaking on any subject before the meeting, shall sign this Constitution, inscribing his name and the title of the society from which he receives his appointment.

DUES.

SEC. 2. The annual dues for membership in this Association shall be five dollars.

DUES—TO BE PAID.

SEC. 3. No member is eligible to office, nor can he speak or vote in this Association or in any of its branches, until his annual dues are paid.

DUES—IF UNPAID.

SEC. 4. If the dues of any member remain unpaid for two years, his name shall be erased from the list of members of this Association.

CONDUCT OF MEMBERS.

SEC. 5. Any act of special immorality or unprofessional conduct committed by a member of this Association shall be referred to the Executive Committee, whose duty it shall be to thoroughly examine into the case, and if the charges be sustained to report at the next meeting of the annual session at which the charges are preferred. Whereupon, by a vote, the offending member may be reprimanded or expelled, a two-thirds vote being required for expulsion, a majority being sufficient for reprimand.

EXPELLED MEMBERS.

SEC. 6. Any member of this Association being expelled or suspended from his local society shall from that date cease to be a member of this body.

RESIGNATION OF MEMBERS.

SEC. 7. Any member not in arrears may offer his resignation, upon the acceptance of which his membership shall cease; but the Association may at any time thereafter reinstate such member by unanimous consent.

ARTICLE VI.

OFFICERS.

SECTION 1. The officers of this Association shall be a President, three Vice-Presidents, Corresponding Secretary, Recording Secretary, Treasurer, and an Executive Committee consisting of nine members.

TERM OF OFFICE.

SEC. 2. Each officer, except as otherwise provided, shall hold his appointment for one year, or until another is elected and qualified to succeed him.

ELECTION OF OFFICERS.

SEC. 3. The President, Vice-Presidents, Corresponding Secretary, Recording Secretary, Treasurer, and members of the Executive Committee shall be elected by ballot in open session of the Association. Three members of the Executive Committee shall be chosen from each division.

After 1897 the President shall be chosen from the division in which the meeting is being held.

SEC. 4. One of the Vice-Presidents shall be chosen from each section, namely, one from the East, one from the West, and one from the South, and shall rank by seniority.

SEC. 5. The candidates for President and Vice-Presidents shall be nominated by an informal ballot of the Association. The three names, or, in case of a tie, the four names, having the greatest number of votes shall be the sole nominees.

A formal ballot shall then be taken, in which a majority of the ballots cast shall be necessary to a choice.

The informal ballot may be made formal by a three-fourths vote of the members present.

ARTICLE VII.

DUTIES OF OFFICERS.

Duties of President.

SECTION 1. The President shall preside according to parliamentary usage as laid down in "Roberts's Rules of Order" and the rules of order adopted by this Association, and shall present an annual address.

Duties of Vice-Presidents.

SEC. 2. In the absence of the President, one of the Vice-Presidents shall perform the duties of the office, and in the absence of these officers a chairman *pro tem.* shall be appointed by the Executive Committee.

Duties of Corresponding Secretary.

SEC. 3. The Corresponding Secretary shall attend to the correspondence of the Association with the societies therein represented, and with other scientific bodies as may be desirable.

Duties of Recording Secretary.

SEC. 4. The Recording Secretary shall keep accurate minutes of the proceedings of the Association, preserve the archives and unpublished documents, and attend to the other duties that pertain to his office. He shall be *ex officio* chairman of the Publication Committee, and shall see that due notice is given of the time and place of the meetings of the Association.

Duties of Treasurer.

SEC. 5. The Treasurer shall hold all the moneys belonging to the Association, and shall keep an accurate account as between the Association and its members. He shall furnish bonds satisfactory to the Executive Committee. He shall attend the meeting of the Executive Committee at 8 A.M. on the day of the annual meeting to receive dues, and shall attend at roll-call to verify the list of names, checking all such as are in arrears for dues; he shall restore such names upon payment of dues within the legal limits, and shall notify all whose names may be erased from the list of membership. He shall pay the drafts of the Secretary, countersigned by the President, and shall report to the Executive Committee, where his accounts shall be audited and by whom his report shall be presented to the Association, together with their own.

SEC. 6. All resolutions appropriating money, except for the legitimate expenses of this Association, shall require a two-thirds vote of all the members present.

ARTICLE VIII.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall consist of nine members, and shall be the business committee of the Association, to whom shall be referred all business not otherwise specially provided for. They shall report at each meeting, under the proper head, their doings for the current year.

CLASSIFICATION OF EXECUTIVE COMMITTEE.

SEC. 2. At the first election of the Executive Committee the first three shall be elected to serve three years, the second three for two years, and the last three for one year, and thenceforward three new members shall be elected each year by ballot, one from each division, to serve three years, and in case of the absence of any member of this committee his place may be temporarily filled by the remaining members of the committees.

SUB-DIVISION OF EXECUTIVE COMMITTEE.

SEC. 3. The Executive Committee shall meet after the election of new members to choose their own chairman and secretary, and to divide themselves into sub-committees of three each, as follows, and for the purposes described:

First Division.—Committee of Arrangements.

SEC. 4. The first division of this committee shall act as the Committee of Arrangements, and shall make suitable preparations for the meetings of the Association, of which they shall have the charge. These three shall provide a book for the registration of members or visitors as they arrive, with the place of their residence and hotel address, and shall attend to the general wants of the Association during its session; and it shall be their further duty to secure from the Treasurer a good and sufficient bond.

Second Division.—Credentials and Auditing Committee.

SEC. 5. The second division shall examine and verify the credentials and qualifications of members, including all violations of the Code of Ethics and the Constitution, and shall also be the Auditing Committee for that year.

Third Division.—Committee on Volunteer Essays.

SEC. 6. The third division shall examine all volunteer essays, and before they are read to the Association shall give their approval, in order that time may not be taken up by unworthy or irrelevant matter.

They shall report names of places for the next meeting of the Association.

REPORTS OF SUB-COMMITTEES.

SEC. 7. Each of these sub-committees shall report from time to time, as may be necessary, to the Executive Committee as a whole, who shall decide upon such report if possible; but in case of their inability to decide upon any matter, it shall be brought before the Association for its decision as early as practicable.

MEETINGS OF EXECUTIVE COMMITTEE.

SEC. 8. The Executive Committee shall, if possible, meet for consultation and arrangement of their respective duties on the day preceding the annual session of the Association, and shall meet for the examination of credentials and the reception of papers, and such other business as may properly come before them, at 8 A.M. on the first day of the annual meeting.

CHAIRMAN MAY CONVENE THE COMMITTEE.

SEC. 9. The chairman of the Executive Committee may at his own dis-

cretion summon the members thereof to a meeting at any suitable hour during the sessions of the Association, and at any other time at the request of five members of the committee.

ARTICLE IX.

LOCAL COMMITTEE OF ARRANGEMENTS.

SECTION 1. There shall be appointed by the President annually a committee of three residing at or near the place selected for the next meeting, whose duty it shall be to assist the Executive Committee to procure rooms for meetings, and make such other local arrangements as may be needed for the Association.

PUBLICATION COMMITTEE, HOW APPOINTED.

SEC. 2. The President shall appoint two members of this Association who shall act in conjunction with the Recording Secretary as the Publication Committee. The committee shall be authorized to employ a competent reporter to furnish an accurate report of the proceedings of each meeting.

INSTRUCTIONS TO THE PUBLICATION COMMITTEE.

SEC. 3. The Publication Committee shall superintend the publication and distribution of such portions of the transactions as the Association may direct, or the committee judge to be of sufficient value. They shall specify in the annual report of this committee the character and cost of the publications of the Association during the year, and the number of copies still on hand.

SEC. 4. Any report or other paper, to be entitled to publication in the volume of the transactions for the year in which it shall be presented to the Association, must be placed in the hands of the Publication Committee within twenty days after the close of the annual session, and must also be so prepared that the proof sheets furnished the authors shall be returned to the committee without material alteration or addition.

SEC. 5. Every paper received by this Association, and all plates or other means of illustration, shall be considered the exclusive property of the Association, and shall be published for its benefit.

DISCLAIMER.

SEC. 6. The Publication Committee is hereby instructed to print at the beginning of each volume of the transactions the following disclaimer, viz, "The National Dental Association, although formally accepting and publishing the reports of the various Sections and the essays read before the Association, holds itself wholly irresponsible for the opinions, theories, or criticisms therein contained, except when otherwise decided by special resolution."

ARTICLE X.

QUORUM.

Fifteen members shall constitute a quorum for the transaction of business in this Association.

ARTICLE XI.

SUSPENSION OF RULES.—THREE-FOURTHS TO VOTE.

The regular order of business may be temporarily suspended by a three-fourths vote of all the members present, for the consideration of a specific subject, upon the completion of which the regular order shall be at once resumed.

ARTICLE XII.

TIME AND PLACE OF MEETINGS.

SECTION 1. The regular meetings of this Association shall be held annually on the first Tuesday after the last Saturday in August, or at such time as shall be determined by ballot of the Association.

SEC. 2. The place of meeting shall be determined each vear by vote of the Association, except that the place of meeting shall be in the West in 1898, in the East in 1899, and in the South in 1900, and thereafter in the order named, meeting in each section every third year.

SEC. 3. For the purposes of this Association, the United States shall be divided into three divisions, to be called The East, The South, and The West.

The East shall include New England, New York, New Jerscy, Pennsylvania, Ohio, Indiana, lower peninsula of Michigan, and Ontario.

The South shall include Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Kentucky, Tennessee, Arkansas, Oklahoma, and Indian Territory.

The West shall include Illinois, Missouri, Wisconsin, upper peninsula of Michigan, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Kansas, Montana, Wyoming, Colorado, Idaho, Utah, Washington, Oregon, Nevada, California, Arizona, New Mexico, and Alaska.

ARTICLE XIII.

ORGANIZATION OF SECTIONS.

SECTION 1. This Association shall be divided into ten Sections, as follows:

1. Prosthetic Dentistry, Metallurgy, and Chemistry, including Crown- and Bridge-Work.
2. Dental Education, Literature, and Nomenclature.
3. Operative Dentistry.
4. Histology and Microscopy.
5. Materia Medica and Therapeutics.
6. Physiology and Etiology.
7. Anatomy, Pathology, and Surgery.
8. Hygiene and Prophylactic Dentistry.
9. Orthodontia.
10. Clinics.

SEC. 2. It shall be the duty of each member to identify himself with one or more of the above-named Sections, and he shall inform the Recording

Secretary of his choice at the time of joining the Association. At the close of the morning session of the second day of the annual meeting, the roll of permanent members in good standing shall be called for the annual reorganization of the Sections.

SEC. 3. The Secretary shall assign members to the Sections in which they are expected to work if they shall fail to make their own choice.

SEC. 4. It shall be the duty of the Recording Secretary, immediately at the close of the morning session of the second day, to present lists of the names of each Section, as a basis for the organization of the Sections.

SEC. 5. The officers of each Section shall be a chairman and secretary, who shall be appointed by the President upon nomination by the Executive Committee, and shall be members known to be capable and interested in the performance of the duties of the offices.

SEC. 6. The chairman of each Section shall preside at all of its meetings; shall exercise general supervision over the business, and shall see that the labors of his Section are conducted in the manner calculated to secure the best results. The chairman, and such other member or members as the Section shall select, shall prepare and read at the annual meeting of the Association next ensuing a paper or papers on the advances and discoveries of the past year in the branches included in the Section. The reading of such papers shall not together occupy more than forty minutes.

SEC. 7. The several Sections shall meet at 10 A.M. on the morning of the first day of the annual meeting of the Association.

SEC. 8. For the information of all members, a list of the members of each Section shall be published in the Transactions of each year.

SEC. 9. The reports of the Sections shall be called by the President in consecutive order, beginning each succeeding year one number higher than on the preceding year, and no Section having been called and passed shall be again heard until all others have been called.

ARTICLE XIV.

BRANCHES.

SECTION 1. For the wider diffusion of the benefits of this Association, the members of each division may form themselves into one or more separate bodies, to be styled "Branches."

POWERS AND OBLIGATIONS.

SEC. 2. Branches shall have such powers and privileges, and be subject to such obligations, as shall be determined upon from time to time by the National Association in annual meeting.

GOVERNMENT.

SEC. 3. Each branch shall be free to hold meetings and to govern itself as its members shall think fit, but no branch law shall be valid which, in the opinion of the National Association, may contravene any fundamental law of the Association.

EXPENSES.

SEC. 4. Each branch shall pay its own expenses, and no branch shall be deemed for any purpose the agent of the Association, or have power to incur any obligation in its behalf.

PROCEEDINGS.

SEC. 5. Each branch shall furnish a copy of its proceedings, including papers and discussions, for publication with the Transactions of the National Association.

DELEGATES.

SEC. 6. Each branch may receive delegates from societies within its division upon the same conditions as the National Association, and which shall have the same standing in the National Association as though admitted directly from the State societies.

DUES.

SEC. 7. The annual dues of members attending the branches shall be paid to the branch treasurer. Two-fifths of the dues r ay be retained for the benefit of the branch. The remaining three-fifths shall be paid over to the Treasurer of the National Association.

SEC. 8. The annual meeting of any branch shall be omitted whenever the annual session of the National Association shall be held in its division.

RULES OF ORDER.

1. On the arrival of the hour of meeting, the President shall take the chair, call to order, and announce that the meeting is open for business.

2. No motion or speech shall be in order until the mover or speaker shall have been recognized and assigned the floor by the chair, nor shall a motion be open for debate until seconded and stated by the chair.

3. No one shall be permitted to address the Association before giving his name and residence, which shall be distinctly announced from the chair; nor shall he speak more than twice, nor longer than fifteen minutes in all, unless by consent of the Association.

4. At the request of any member a motion shall be put in writing.

5. At the request of five members a question shall be divided, or the yeas and nays ordered.

6. When a question is under debate no other motion shall be in order, except, first, to adjourn; second, to lay on the table; third, the previous question; fourth, to postpone; fifth, to commit; sixth, to amend; and these motions shall take precedence in the order here stated.

7. The previous question, and the motions to adjourn, to lay on the table, and to postpone shall be decided without debate.

8. A motion to adjourn shall always be in order, but no member can make such a motion while another is speaking or while a vote or ballot is being taken.

9. A second amendment to the main question shall not be in order until the first is disposed of, nor shall there be an amendment of an amendment to an amendment.

10. After a motion has been seconded and stated by the chair, it shall not be withdrawn without the consent of the Association.

11. No member shall interrupt another while speaking, except to raise a point of order.

12. When called to order, a member shall sit down until the point of order is decided by the chair, or, in case of appeal, by the Association. If the point of order be sustained, the member can proceed in order by the consent of the Association.

13. Every member shall vote upon a question unless excused by the Association.

14. When any motion, except to adjourn, has been rejected, it shall not be renewed without unanimous consent.

15. Any member who on a question voted in the majority may move a reconsideration of that question; but if that motion shall be lost or laid upon the table, it shall not be renewed without unanimous consent.

16. The President may vote with the members upon all questions, but having so voted shall not give the casting vote in case of a tie.

17. Motions for filling blanks shall be put in the order in which they are moved.

18. On a division, or in voting by yeas and nays, any member may change his vote before the result is declared.

19. These rules may be suspended by unanimous consent.

ORDER OF BUSINESS.

1. Meeting of the Executive Committee, filling of vacancies therein, examination of credentials, and payment of dues, 8 A.M.

2. Meetings of the Sections at 10 A.M.

3. Organization of the Association at 11 A.M.

4. Calling the roll of qualified members.

5. Reading of the minutes, and action thereon.

6. Reports of officers, special committees, and miscellaneous business.

7. The reading and consideration of the stated annual reports from the Sections, together with volunteer papers upon the same subjects in their consecutive order.

In 1898,	commencing	with	Section	1
1899,	"	"	"	2
1900,	"	"	"	3
1901,	"	"	"	4
1902,	"	"	"	5
1903,	"	"	"	6
1904,	"	"	"	7
1905,	"	"	"	8
1906,	"	"	"	9
1907,	"	"	"	10
1908,	"	"	"	1

8. Report of Executive Committee.

9. Balloting for the place of next annual meeting.

10. Election of officers and three members of Executive Committee.
11. Instructions to the permanent committees.
12. Unfinished, new, and miscellaneous business.
13. Reading of minutes.
14. Installation of officers.
15. Final reading of minutes.
16. Adjournment.

AMENDMENTS.

The Constitution, Rules of Order, and Order of Business of this Association may be altered or amended at any annual session by unanimous consent of the members present, providing notice has been given in writing at a previous meeting of the annual session at which the amendment is proposed; or by a vote of two-thirds of the members present, providing notice of the alteration or amendment has been given in writing at a previous annual session.

STANDING RESOLUTIONS.

The following standing resolutions are in force at this time:

1. *Resolved*, That a paper presented to the Committee on Voluntary Essays, and by them considered and returned to the writer with notification that the said paper is not accepted, cannot afterward be read before the Association unless it is made the special order by resolution adopted.

2. *Resolved*, That this Association discountenances the giving of banquets, excursions, entertainments, etc., by local professional societies or individuals, either during or at the close of our annual meetings.

3. *Resolved*, That it is unprofessional to use on cards or signs anything except name, title, and address.

4. *Resolved*, That this Association now in session direct that Sections belonging thereto shall in the future be prohibited from inviting individuals who are violating the Code of Ethics to hold clinics, or to give other exhibitions before this body.

5. *Resolved*, That two general addresses be delivered annually, on the second and third days' meetings, on some general topics of interest to the whole profession, the subjects to be selected by the third division of the Executive Committee, the first division of the Executive Committee to nominate the essayists annually.

6. *Resolved*, That a Standing Committee of three be appointed, to be known as the Committee on Terminology, whose duty it shall be to prepare and submit a carefully prepared report at each annual meeting of this Association.

7. *Resolved*, That this Association believes the conferring of honorary degrees in dentistry to be detrimental to the profession of dentistry, and hereby expresses its disapprobation of the practice.

8. *Resolved*, That a committee of three be appointed by the chair to cooperate with the Army Medical Museum and Library managers in enriching its stores of dental literature and specimens, especially by appealing to dental societies and individual members of the dental profession for assistance.

9. *Resolved*, That the National Dental Association condemns the use of secret preparations known as "*local anesthetics*," as well as all other secret preparations.

10. *Resolved*, That the secretary or other officer of each society sending delegates to this Association is expected to make a general report of the work done by the society he represents during the year, giving the subjects of the papers read before them and digests of the same, and to send reports to the Secretary of this Association at least three weeks before the date of each annual meeting; the reports to be forwarded to the chairman of the Section to which they belong.

11. *Resolved*, That any member of the dental profession who has been in reputable practice for a period of fifty years may be elected to permanent membership in the Association without payment of dues, and any member of this Association who has been in practice for a like period shall have his dues remitted thereafter by presenting the fact to the Treasurer of the Association.

12. *Resolved*, That lists of the ex-Presidents of the American Dental Association and of the Southern Dental Association shall be published annually in the Transactions of the National Dental Association, and that all members and officers hold the same relation to the National Dental Association that they did to the former associations.

MEMBERS

OF THE

NATIONAL DENTAL ASSOCIATOIN.

List of members as certified by the Treasurers of the American Dental Association and Southern Dental Association, in accordance with the resolution adopted at the first day's session, and which reads as follows:

Resolved, That the Treasurer of this Association be directed to request the Treasurers of the American Dental Association and of the Southern Dental Association to furnish him with the lists of the permanent members of their respective Associations, and he is hereby directed to add the names so furnished him to the Constitution of this Association as set forth in the provisions of membership in Article III, Section 5, of the Constitution; and be it further

Resolved, That said act of the Treasurer shall be legal and binding the same as if the signatures had been attached by the persons themselves.

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MCQUILLEN, DANIEL N., (A.D.A.)	1628 Chestnut st., Philadelphia, Pa.
NASON, GEO. S., (A.D.A.)	446 Bee Building, Omaha, Neb.
NELSON, J. J., (A.D.A.)	330 S. 15th st., Philadelphia, Pa.
NOBLE, H. B., (A.D.A., S.D.A.)	1324 New York ave., Washington, D.C.
NOEL, L. G., (S.D.A.)	Church st., Nashville, Tenn.
NORTHROP, A. L., (A.D.A.)	57 W. 49th st., New York, N. Y.
NOYES, EDMUND, (A.D.A.)	Stewart Bldg., Chicago, Ill.
ORRISON, J. E., (S.D.A.)	Baltimore, Md.
OTTOFY, LOUIS, (A.D.A.)	1228 Masonic Temple, Chicago, Ill.
OTTOLENGUI, R., (A.D.A.)	115 Madison ave., New York, N. Y.
PAGE, W. E., (A.D.A.)	16 Arlington, cor. Newbury, Boston, Mass.
PALMER, CORYDON, (A.D.A.)	Warren, Ohio. (Permanent without dues.)
PALMER, S. B., (A.D.A.)	225 S. Warren st., Syracuse, N. Y.
PARRAMORE, T. H., (S.D.A.)	Hampton, Va.
PATTERSON, J. D., (A.D.A.)	Keith & Perry Bldg., Kansas City, Mo.
PECK, A. H., (A.D.A.)	Stewart Bldg., Chicago, Ill.
PEIRCE, C. N., (A.D.A.)	1415 Walnut st., Philadelphia, Pa.
PERRY, S. G., (A.D.A.)	46 W. 37th st., New York, N. Y.
PFEIFER, JOSEPHINE D., (A.D.A.)	1003 Masonic Temple, Chicago, Ill.
PRESSEY, B. J., (S.D.A.)	Newport News, Va.
PRESSEY, J. B., (S.D.A.)	Hampton, Va.
PRICE, W. A., (A.D.A.)	2238 Euclid ave., Cleveland, Ohio.
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PRUYN, CHAS. P., (A.D.A.)	100 State st., Chicago, Ill.
QUATTLEBAUM, E. G., (S.D.A.)	Columbia, S. C.
QUATTLEBAUM, J. W., (S.D.A.)	Columbia, S. C.
REITZ, R. B., (A.D.A.)	244 E. 50th st., New York, N. Y.

REMINGTON, F. A., (A.D.A.)	57 W. 49th st., New York, N. Y.
RHEIN, MEYER L., (A.D.A.)	38 E. 61st st., New York, N. Y.
RICH, JOHN B., (A.D.A.)	1205 G st., Washington, D. C. (Permanent without dues.)
RICHARDS, W. H., (S.D.A.)	Knoxville, Tenn.
RICHARDSON, W. E.,* (A.D.A.)	101 Main st., Batavia, N. Y.
ROBERTS, NORMAN J., (A.D.A.)	Waukegan, Ill.
ROHLAND, C. B., (A.D.A.)	123 Third st., Alton, Ill.
ROSS, A. O., (A.D.A.)	807 N. High st., Columbus, O.
RUST, D. N., (S.D.A.)	Alexandria, Va.
RUTLEDGE, B., (S.D.A.)	Florence, S. C.
SANGER, R. M., (A.D.A.)	551 Main st., East Orange, N. J.
SARRAZIN, J. J., (S.D.A.)	New Orleans, La.
SEIP, HOWARD S., (A.D.A.)	Allentown, Pa.
SHARP, S. P., (S.D.A.)	Knoxville, Tenn.
SHEPARD, L. D., (A.D.A.)	330 Dartmouth, cor. Beacon st., Boston, Mass.
SHIELDS, NELSON T., (A.D.A.)	154 Madison ave., New York, N. Y.
SHOTWELL, F. A., (A.D.A.)	Rogersville, Tenn.
SHRYOCK, W. W., (A.D.A.)	27 W. Berry st., Ft. Wayne, Ind.
SIBLEY, A. H., (A.D.A.)	800 N. 16th st., Philadelphia, Pa.
SILL, CHARLES, (S.D.A., A.D.A.)	301 W. 12th st., New York, N. Y.
SIMPSON, I., (S.D.A.)	Rock Hill, S. C.
SISSON, H. H., (A.D.A.)	503 Fifth ave., New York, N. Y.
SMITH, B. HOLLY, (S.D.A., A.D.A.)	Baltimore, Md.
SMITH, D. D., (A.D.A.)	1629 Walnut st., Philadelphia, Pa.
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SMITH, H. T., (A.D.A.)	116 Garfield Place, Cincinnati, Ohio.
SMITH, J. W., (S.D.A.)	Baltimore, Md.
SMITH, L. A., (S.D.A.)	Fort Gibson, Miss.
SMITH, M. C., (A.D.A.)	Room 3, Lee Hall, Lynn, Mass.
SMITH, W. SCOTT, (A.D.A.)	227 W. Chestnut st., Louisville, Ky.
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STRAIGHT, M. B., (A.D.A.)	80 W. Huron st., Buffalo, N. Y.
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SWAIN, E. D., (A.D.A.)	Stewart Bldg., Chicago, Ill.

*Deceased December 5, 1897.

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TURNER, V. E., (S.D.A.) . . .	Raleigh, N. C.
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VAN DE WATER, J. N., (A.D.A.) .	Madison, N. J.
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VERPLANCK, ROBT. I., (A.D.A.) .	4 Kenmore Place, Albany, N. Y.
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WALKER, R. H., (S.D.A.) . . .	Norfolk, Va.
WALKER, W. E., (S.D.A.) . .	Pass Christian, Miss.
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WHITBY, T. P., (S.D.A.) . . .	Selma, Ala.
WHITE, GORDON, (S.D.A.) . .	Nashville, Tenn.
WHITE, J. H., (S.D.A.) . . .	Elizabeth City, N. C.
WHITFIELD, G. M., (A.D.A.) . .	215 S. 6th st., Newark, N. J.
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WOOLSEY, W., (A.D.A.) . . .	1162 East Jersey st., Elizabeth, N. J.
WRIGHT, G. F. S., (S.D.A.) . .	Georgetown, S. C.

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PETERMANN, ADOLPH	Frankfort-on-the-Main, Germany.
LANGSTORF, GEORGE VON . . .	Friedburg, Baden.
TURNER, J. SMITH, (M.R.C.S.) . .	London, England.
TOMES, CHARLES S.,(M.A.,M.R.C.S.)	London, England.
TOMES, SIR JOHN,* (F.R.S.,M.R.C.S.)	London, England.
MAGITOT, E.,* (M.D.) . . .	Paris, France.
STEVENS, MORDAUNT, (M.D.,D.D.S., M.R.C.S.)	Paris, France.
WEDL, FR.	Vienna, Austria.
HERBST, WILHELM	Bremen, Germany.
BRYAN, L. C.	Basel, Switzerland.
THACKSTON, W. W. H. . . .	Farmville, Va.

* Deceased.

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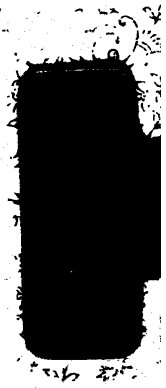

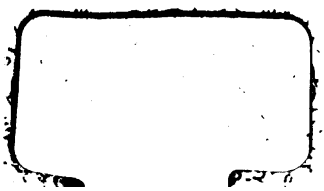

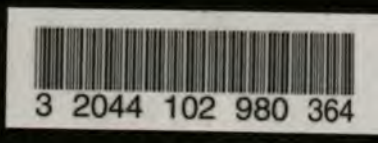
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